IMPACT

Recent Success Stories

College of Agriculture and Life Sciences

North Carolina Agricultural Research Service
North Carolina Cooperative Extension Service

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NC STATE UNIVERSITY

A MESSAGE FROM THE DIRECTORS

Improving the quality of life — especially the economic well-being — of North Carolinians and others has been part of the mission of the College of Agriculture and Life Sciences at North Carolina State University since its inception. The college has a deep commitment to learning more about the world and to sharing that knowledge with students, with other researchers and educators, and with any member of society who might benefit.

In the following pages, we outline just a few of the benefits that have been derived from our recent research and extension successes — examples of the many ways our faculty members, working with our partners in both the public and private sectors, are solving real-world problems for real-world industries and individuals.

In these pages, we begin to measure the impact of these research and extension efforts in real terms — dollars earned and saved, pounds of farm chemicals kept out of rivers, numbers of people who've changed behaviors and enhanced their lives, for starters. But it is, in the end, difficult to capture the ultimate value of these efforts. After all, who can put a dollar value upon the well-educated student who develops a widely used cancer screening test? A farmer who's learned the business and stress management skills to steer the family operation through difficult economic times? Or a 4-H'er who learns the leadership skills that enable him to become a governor or a four-star general? In today's fast-changing world, the value of knowledge and technology is truly incalculable.

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DEVELOPING AQUACULTURE

ISSUE: With wild populations of fish and other seafood dwindling, researchers are looking to aquaculture to help supplement America's insatiable appetite for seafood. In addition, aquaculture can provide new products for the seafood market and new business opportunities for farmers.

WHAT HAS BEEN DONE: North Carolina State University, with Sea Grant support, has been a leader in the development of hybrid striped bass aquaculture. Researchers in the College of Agriculture and Life Sciences at North Carolina State University learned how to raise and reproduce hybrid striped bass in captivity. North Carolina Cooperative Extension Service specialists then worked with growers to develop a hybrid striped bass aquaculture industry in the state.

IMPACT: Before North Carolina State University began developing production methods in the early 1980s, there was no hybrid striped bass production in North Carolina. North Carolina growers now sell about a million pounds of hybrid striped bass annually, producing $3 million plus in income from the sale of mature fish and $1 million from the sale of fingerlings to other growers. North Carolina has become a center of hybrid striped bass aquaculture.

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HIGH-DENSITY APPLE ORCHARDS

ISSUE: Trees in conventional apple orchards usually do not bear fruit significantly until their fifth to seventh growing season after planting. At the same time, the trees can be more than 20 feet high, necessitating the use of often hard-to-locate labor to prune the trees and pick the fruit. Gaining access to conventional trees can also increase an orchard owner's liability costs. As a result, apple growers in Western North Carolina and elsewhere are hard-pressed to realize early returns on orchard investments and find it difficult to get orchards with newer varieties into production quickly.

WHAT HAS BEEN DONE: Using precocious, dwarfing rootstocks, researchers in the College of Agriculture and Life Sciences at North Carolina State University evaluated techniques for producing high-yield, 8-to-10-foot-high dwarf apple trees that bear a significant amount of fruit in their third year. Research and extension demonstrations have shown that in North Carolina high-density orchards can break even economically in their sixth to seventh year, compared with a 10-to-12-year break-even time for conventional orchards.

IMPACT: An estimated 5 percent of the acreage devoted to apples in North Carolina — roughly 10,000 acres — has been planted in high-density orchards, while roughly half the state's apple growers are trying some element of the new technology. Using this technology, growers can cut the time to production roughly in half, paying off orchard investments earlier, resulting in a better return on investment. Growers may also cut their labor costs and reduce the amount of pesticide they use; because the trees are smaller, they require less pesticide. Researchers anticipate potential pesticide reductions of 50 to 75 percent.

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SOYBEAN OIL CONTENT

ISSUE: Soybean oil is an ingredient in a number of foods. But soybean oil has drawbacks. It contains more polyunsaturated fatty acids than some other oils. Because the presence of polyunsaturated fatty acids tends to limit the shelf life of foods, a process called partial hydrogenation must be used during processing. Partial hydrogenation alters polyunsaturated fatty acids, extending the shelf life of products that contain them. Yet partial hydrogenation leads to the formation of trans fatty acids, which have been implicated in cardiovascular disease. If the polyunsaturated fatty acid content of soybean oil could be reduced, the expense of partial hydrogenation and the formation of trans fatty acids could be avoided. Foods containing soybean oil with reduced polyunsaturated fatty acids would be less expensive to produce and healthier.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University have isolated a gene in soybeans that plays a role in oil synthesis and have produced transgenic soybean plants in which this gene has been altered.

IMPACT: With an understanding of this gene, it appears it may be possible to alter the ratio of polyunsaturated and monounsaturated fatty acids in soybeans and perhaps other plants grown for their oil to reduce the amount of polyunsaturated fatty acid. Soybeans with less polyunsaturated fatty acid should be a boon to food processors. And if processors consider such soybeans more valuable, farmers may ultimately be able to demand a higher price for their crops.

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TARGETING NEMATODES

ISSUE: Parasitic nematodes reduce the yield of the world's 40 major food staples and cash crops by an average of 12.3 percent annually, leading to losses of more than $5.8 billion in the United States alone. Nematicides have been for some 50 years the primary defense against the particularly problematic root-knot and cyst nematodes, but many of these highly toxic and environmentally damaging chemicals are no longer available to farmers. The most environmentally and economically sound approach for nematode management would be to plant varieties that are less susceptible to the pest, but only a few resistant varieties of a few crops are available.

WHAT HAS BEEN DONE: Scientists with North Carolina State University's College of Agriculture and Life Sciences have identified and are characterizing large suites of genes that function at nematode feeding sites. The goal is to use this understanding to develop transgenic crops that are resistant to root-knot nematode damage and to design advanced bioactive agents to interfere with parasitic nematode biology.

IMPACT: Ultimately, scientists will be able to use this understanding to develop transgenic crop varieties that are resistant to nematodes and other root pathogens. These cultivars not only may be higher yielding and less susceptible to other stresses, such as drought, they also will help reduce the reliance on traditional chemical controls that can damage the environment. Another goal is to design novel chemicals that specifically disrupt root-knot and cyst nematode biology. In conjunction with precision farming techniques, such agents will afford environmentally sound and cost-effective nematode control.

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PROTECTING PEANUTS

ISSUE: North Carolina peanut farmers used to protect their crops from a disease called leafspot by spraying fungicide at regular intervals on a predetermined schedule. Such spraying can be costly and sometimes unnecessary.

WHAT HAS BEEN DONE: North Carolina Cooperative Extension Service specialists at North Carolina State University came up with a better way of controlling leafspot. The disease infects crops only under certain weather conditions. By monitoring the weather, specialists were able to predict when the disease was likely to infect crops. Using this information, farmers spray only when disease outbreaks are likely.

IMPACT: Using the leafspot advisory, farmers can cut their fungicide use dramatically. Depending on the weather in any given year, North Carolina farmers save from $1 million to $2.5 million in fungicide costs.

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...AND POTATOES

ISSUE: On average, North Carolina potato producers apply organophosphate or carbamate insecticides to the potato crop one or two times each year to control the European corn borer. In addition to posing environmental and health hazards, using these chemicals against the corn borer also fosters the development of resistance in another insect pest, the Colorado potato beetle, making it difficult and costly to control.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University have demonstrated that the highly visible injury to the potato plants caused by the European corn borer larvae does not result in a reduction in yield or quality of the tubers at harvest.

IMPACT: Knowledge that even very high infestations of European corn borer do not result in lost yield or quality will enable North Carolina potato producers to eliminate one to two insecticide applications each season. It is now possible to produce potatoes commercially in North Carolina with at most one insecticide application and in many situations without using any synthetic insecticides. These applications cost roughly $10 per acre, so eliminating two applications across North Carolina's 17,500 acres of potatoes could save farmers a total of $350,000 annually.

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ORGANIC FARMING FACTS

ISSUE: Dramatic quota cuts for tobacco, plus low prices for many other major commodities, have spurred many farmers to consider producing for new markets, including the market for certified organic crops. Unfortunately, little practical information has been available to those interested in organic farming.

WHAT HAS BEEN DONE: To help Cooperative Extension agents fill the information gap, specialists with North Carolina State University's College of Agriculture and Life Sciences provided an organic farming systems training program and prepared a resource manual, informational leaflets and slide sets. They also put together a Web site with links to other research-based information about organic farming.

IMPACT: As a result of the training, 52 North Carolina Extension agents have an enhanced knowledge base to provide sound, research-based advice to organic growers. They are better equiped to help potential organic farmers get into the business and to help farmers transition to profitable organic farming enterprises.

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CONTROLLING DRAINAGE

ISSUE: Nitrogen can move from farm fields, where it is a valuable fertilizer component, to groundwater and surface waters. In groundwater used for drinking, nitrogen in excessive amounts can pose a risk to human health. In surface waters, it can fuel fish-killing algae blooms. Nitrogen in surface waters is also suspected to be one of the stimulants of *Pfiesteria piscicida*, a posionous dinoflagellate that is lethal to fish and believed toxic to recreational water users.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University developed a system known as controlled drainage to decrease the amount of nutrients moving from farm fields to surface waters. Farmers install a system of culverts and boards in ditches; using the system, they can release water when fields are wet yet retain some for drier times. North Carolina has deemed the environmental benefits of the practice so great that the state shares with farmers the cost of installing the drainage structures.

IMPACT: Controlled drainage helps protect the environment and increases crop yields. On farms with controlled drainage, about half the nitrogen previously lost to surface water is converted to nitrogen gas, which is absorbed harmlessly by the atmosphere. As a result of North Carolina Cooperative Extension Service programs, controlled drainage has been adopted on some 600,000 North Carolina acres. The practice has also spread to other states and countries. In North Carolina, increased corn and soybean yields that result from the irrigation value of controlled drainage are worth $5 million annually.

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BALING TOBACCO

ISSUE: Competition from foreign producers is threatening tobacco, which continues to be an important crop in North Carolina and other states. To remain competitive, farmers must either lower the price or increase the value of their product.

WHAT HAS BEEN DONE: Recognizing that tobacco buyers value baled tobacco grown by foreign competitors, North Carolina Cooperative Extension Service specialists in the College of Agriculture and Life Sciences at North Carolina State University looked for ways to make baling a feasible alternative to loose-leaf tobacco in the United States. They developed a high-tech computerized baler and demonstrated it on farms throughout the five-state flue-cured tobacco-producing region. They also administered a bale-tag registry, which tracks baled tobacco.

IMPACT: As a result of the North Carolina State University effort, baling caught on quickly with tobacco growers in North Carolina and elsewhere. In 1997, only 8,000 bales of tobacco, .6 percent of total sales, were sold in the nation's five flue-cured tobacco-producing states. In 1998, the number jumped to 132,934 bales, or 11 percent of total sales. In 1999, 535,380 bales were sold, accounting for 54 percent of the nation's tobacco crop. At the same time, a small manufacturing and sales industry has developed to serve farmers who want balers and baling wire. Farmers have found that baling decreases labor costs, while the bales are easier to store and transport. Buyers enjoy decreased handling and transportation costs and improved inventory control. And because bales can be tagged and wired in such a way that they can't be easily taken apart, buyers and farmers have found that baling provides a means of ensuring quality.

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FIGHTING FUNGI

ISSUE: Leaf and seed blights caused by *Cercospora* fungi cause American farmers significant crop losses each year. Annual losses to soybeans alone are $125 million.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University genetically transformed Xanthi tobacco, a model system plant, so that it contained a gene called CFP, which occurs naturally in a fungus called *Cercospora kikuchii*. Transgenic plants, normal in appearance, that express both CFP mRNA and CFP protein were recovered. It was hoped that the presence of CFP in these plants would act like a vaccine, protecting the plants from *Cercospora* fungi. Initial greenhouse experiments indicated that disease symptoms (lesion numbers) were suppressed when plants expressing CFP were inoculated with spores of *C. nicotianae*, the species of *Cerospora* fungus that attacks tobacco. These experiments are being repeated.

IMPACT: Cercosporin, the polyketide toxin produced by many *Cercospora* species, is strongly implicated in disease causation. The CFP gene confers a significant level of toxin resistance in *Cercospora* and in other toxin-sensitive fungi that have been tansformed to express CFP. North Carolina State University scientists postulated that the gene might function in plants also to confer toxin resistance. Enhanced resistance to toxin may result in resistance to *Cercospora* infection. It should be possible to put the CFP gene into corn and soybean plants, protecting them from *Cercospora* infection and producing economic gains for growers and processors.

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TACKLING TOXIC OXYGEN

ISSUE: While oxygen is required for life on this planet, slightly modified forms of oxygen can be highly toxic to living organisms. Toxic forms of oxygen have been implicated in such human diseases and syndromes as cancer and aging. Microbes that act as plant parasites also generate toxic forms of oxygen to invade their hosts and cause devastating losses to agricultural production.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University have isolated genes from a plant pathogenic fungus that provide resistance to toxic forms of oxygen. They are studying these genes to determine how they function to provide resistance and using them to genetically engineer plants for resistance.

IMPACT: By genetically engineering plants with genes to protect them against toxic forms of oxygen, scientists can produce plants that have natural resistance to specific diseases and reduce our current dependence on pesticides. In addition, understanding how living cells defend themselves against these forms of oxygen will aid in devising control strategies for both human and plant diseases.

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LIMITING AFLATOXIN ACCUMULATION

ISSUE: Aflatoxins are toxic and carcinogenic mycotoxins produced by the fungus *Aspergillus flavus*. They can accumulate in the seed of corn, peanuts and cotton. Aflatoxin contamination of feed and food costs growers millions of dollars each year and threatens the safety of our food supply. The problem is particularly severe in the Southern United States. Genotypes of corn and peanut have been identified with some resistance to aflatoxin accumulation, but no adequate resistance is available to growers.

WHAT HAS BEEN DONE: Research conducted in the College of Agriculture and Life Sciences at North Carolina State University has led to the isolation of the gene that regulates the entire aflatoxin biosynthetic pathway. At the same time, proteins have been isolated from a genotype of corn that has some resistance to aflatoxin accumulation.

IMPACT: Knowledge of the key regulator of the aflatoxin biosynthetic pathway may allow scientists to target specific chemicals or plant metabolites to the gene and thus prevent the accumulation of aflatoxin. North Carolina State University scientists have been able to make gene reporter constructs using the promoter of this gene. The constructs can be used to screen lines of corn or cotton for their ability to support aflatoxin accumulation. The constructs should help in the identification of new sources of resistance to aflatoxin accumulation. With the isolation of the proteins found in corn it should be possible to identify the genes that produce these inhibitory proteins. Once the genes are isolated they can be used as markers in a breeding program designed to develop corn lines with resistance to aflatoxin accumulation. These two efforts take growers and consumers closer to a time when aflatoxin accumulation in corn, peanuts and cotton is no longer a problem.

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MORE PROFITABLE PEANUTS

ISSUE: In the face of changes in the federal peanut program, growers must reduce their production costs if they are to remain competitive in global markets.

WHAT HAS BEEN DONE: Researchers and extension specialists with North Carolina State University's College of Agriculture and Life Sciences have developed and evaluated integrated pest management approaches for peanuts. These approaches help farmers maintain yields while reducing costs and maximizing economic returns. They also reduce the likelihood of inducing secondary pest problems, further enhancing yields. These approaches have been demonstrated through on-farm, large-plot trials at 13 locations and discussed at field days, workshops, grower meetings and round-table discussions.

IMPACT: Peanut growers in North Carolina can now expect potential savings of $15 per acre from using alternative thrips control measures and $25 per acre by avoiding a rootworm treatment. Farmers also can save up to $30 per acre by using a leafspot advisory system to avoid spider mite outbreaks. In addition, they can scout for caterpillars to avoid unnecessary treatments late in the season and thus save $8 per acre. It is difficult to determine the overall impact in North Carolina from these measures. Not all peanut growers use all these practices, and the savings from many of these practices can vary widely from year to year depending on weather and other factors.

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DEVELOPING AN HERB INDUSTRY

ISSUE: In the 1980s, when land values in portions of North Carolina rose rapidly, farmers found that they needed to produce very high-value crops if agriculture was to remain a viable business. Increasing demand for culinary and medicinal herbs was seen as a viable option for some of these growers.

WHAT HAS BEEN DONE: A research and extension program was developed in North Carolina State University's College of Agriculture and Life Sciences that focuses on commercial production practices for culinary and medicinal herbs and on educating growers on the best production and marketing methods. Researchers are evaluating 25 medicinal herbs at three research stations representing different environmental conditions in the state. The college has worked closely with the state's herb association to make its findings widely available through leaflets, newsletters, conferences, festivals, field days, and the World Wide Web. Meanwhile, to help farmers find markets for herbs, the college has worked in cooperation with the North Carolina Department of Agriculture and Consumer Services to develop an on-line herb business directory.

IMPACT: North Carolina's herb industry has expanded so that there are now more than 150 businesses producing more than 200 acres of culinary and medicinal herbs in fields and greenhouses. These are high-value crops, many of which can provide gross returns in excess of $15,000 per acre. Buyers of bulk botanicals now look to North Carolina as the source of a variety of medicinal herbs.

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BREEDING COLD-HARDY PEACHES

ISSUE: Cold injury to flower buds and young fruit significantly lowers income for North Carolina peach growers. North Carolina's average loss from cold injury is estimated to range from $1 million to $2 million annually. In some years, cold injury results in the total loss of what would otherwise be a $6 million to $8 million crop.

WHAT HAS BEEN DONE: Plant breeders with North Carolina State University's College of Agriculture and Life Sciences have developed three new varieties that are more cold-hardy and, therefore, better suited to the state's climate.

IMPACT: North Carolina's peach growers now have available varieties that are much more likely to produce a fruit crop with consistency from year to year and, thus, increase their yields and income. In addition, the varieties should allow North Carolina growers to expand into new markets and allow for peach production in areas previously deemed unsuitable due to the risk of cold-temperature injury.

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...AND BETTER TOMATOES

ISSUE: One way farmers can stay competitive is by planting new crop varieties that produce higher yields or are more resistant than other varieties to disease or insects. That's why plant breeders are constantly working to produce new and better varieties.

WHAT HAS BEEN DONE: The tomato breeding program in the College of Agriculture and Life Sciences at North Carolina State University has produced a number of new tomato varieties with traits that allow growers to be more competitive. The program's "mountain" series of varieties (varieties such as Mountain Pride, Mountain Delight, Mountain Spring, Mountain Fresh, Mountain Gold, Mountain Belle and Mountain Supreme) has been particularly popular with growers.

IMPACT: The mountain series collectively accounts for the majority of the vine-ripe tomato acreage planted in the Eastern United States. These varieties, representing a wide range of fruit size, season of maturity and fruit color, combine desirable characteristics such as flavor and firmness with genetic resistance to tomato disorders and diseases. Mountain Supreme, for example, was the first variety available to growers with resistance to early blight, the primary foliar disease with which North Carolina growers must contend. Tomato-breeding efforts at North Carolina State University have allowed growers to produce high-quality fruit while reducing pesticide use.

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WAXING SWEET POTATOES

ISSUE: With cash receipts of $58 million, North Carolina is the nation's leading state when it comes to sweet potato production. However, the state has lost market share in recent years because locally grown sweet potatoes sometimes appear to have rough, broken and shriveled skins.

WHAT HAS BEEN DONE: Faculty members with North Carolina State University's College of Agriculture and Life Sciences have found ways to wax sweetpotatoes to give them a smoother, cleaner appearance. Waxing also helps prevent water losses and increases shelf life without additional packaging.

IMPACT: As a result of research and extension education efforts, several North Carolina growers and packers now wax sweetpotatoes. Packers say that waxing gives them a competitive advantage in the market, and retailers and consumers benefit because it reduces shriveling, which can make sweetpotatoes unusable.

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GIVING FARMERS FAIR WARNING

ISSUE: Tobacco blue mold is a fungal disease that can devastate a tobacco crop. Regular spraying with fungicide can help prevent the disease, but spraying more often than necessary can be costly for farmers and to the environment.

WHAT HAS BEEN DONE: Researchers in the College of Agriculture and Life Sciences at North Carolina State University have developed the North American Tobacco Blue-Mold Forecast Center. The center monitors weather conditions, confirmed blue-mold outbreaks, and trajectory paths for blue-mold spores. Using these data, the forecast tells farmers if spores from infected fields are coming to their area and if conditions are right for an outbreak. Farmers can spray more effectively when they follow the forecast and treat their crops only when blue mold threatens.

IMPACT: The center has helped tobacco farmers minimize their losses from blue mold. The prevalence of blue mold in any given year is dependent on weather conditions, and the weather in recent years has not been conducive to the development and spread of the disease. Nevertheless, since 1997, when use of the blue mold forecast became widespread, losses to the disease in North Carolina's burley tobacco crop and fungicide usage have been roughly cut in half compared to previous years. Blue mold losses in North Carolina's flue-cured tobacco crop, which typically is less susceptible to the disease than burley, have been negligible since use of the forecast became widespread.

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MAKING THE MOST OF SPINOSAD

ISSUE: A novel biological insecticide, spinosad, with a novel mode of action recently became available to farmers for the control of critically important pests of cotton, corn, vegetables and other crops. Spinosad is of special significance because it is a new class of insecticide chemistry that is very safe to non-target insects, wildlife and humans and yet highly effective in the control of pest species. The insecticide is also significant because many of the traditional chemical insecticides for controlling pests have been lost or may be lost due to insect resistance or because the insecticides have high toxicity levels that will prevent them from being re-registered. The availability of spinosad is particularly important because its use can be alternated with other biological insecticides like Bt to enhance pest and insecticide resistance management.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University have developed a laboratory strain of the tobacco budworm, a pest of cotton, that is highly resistant to spinosad based on selection dose. This is the first insect strain that is resistant to spinosad.

IMPACT: The development of a spinosad-resistant insect strain demonstrated that this new safe, biological insecticide is at least theoretically at risk of being lost in the field to insecticide resistance. Information on the mechanism and genetics of resistance will be critical in the development of resistance management strategies. This strain also has wide commercial value as a method to screen chemicals for insecticide activity against a new target site in the insect nervous system and should be of great interest to most agricultural chemical companies. The resistant strain also provides a clear path to isolate this novel insecticide target using insect genomics research.

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MANAGING Bt RESISTANCE

ISSUE: The development by insects of resistance to transgenic plants containing toxins of the bacterium *Bacillus thuringiensis* (Bt) presents a serious problem for growers who rely on the safety of this bioengineered, widely-used, natural insecticide to protect their crops. Among the crops protected by *Bacillus thuringiensis* toxins are cotton, corn, tomatoes and potatoes.

WHAT HAS BEEN DONE: Research in the College of Agriculture and Life Sciences at North Carolina State University has demonstrated that insects can, indeed, develop multiple-gene resistance to the complex of toxins produced by this bacterium.
Researchers alerted the scientific and user public to this concern and catalyzed efforts to proactively avoid resistance development.

IMPACT: As a result of this research, environmental agencies, agribusiness and the U.S. Department of Agriculture are seriously re-evaluating the potential for the development of pest resistance to transgenic crops. Due to this research, no longer are transgenic crops considered a panacea for pest control. This work is changing the way transgenic crops are developed and introduced.

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MAKING THE BEST USE OF Bt

ISSUE: Reducing the pesticide load in the environment is among the goals of the U.S. Environmental Protection Agency. Planting Bt transgenic cotton (cotton that expresses a toxin in the plant tissue) reduces the need to spray insecticide on cotton. Cotton farmers are able to plant a large proportion of their acreage in Bt cotton. However, corn farmers in the Cotton Belt, including North Carolina, have been restricted by EPA to planting 5 percent of their acres in Bt transgenic corn hybrids that contain the Bt toxin in corn ears. These corn hybrids provide superior control of several caterpillar pests. However, EPA has been concerned about the potential for the corn earworm, *Helicoverpa zea* (also known as the cotton bollworm), to develop resistance to the Bt toxin should a large amount of Bt corn be planted. Consequently, EPA chose a cautious approach and restricted Bt corn deployment until a science-based assessment of the role that Bt corn plays in hastening bollworm resistance to Bt cotton and strategy for managing resistance were available. Corn growers in North Carolina and elsewhere would like to be able to plant ear-expressing Bt corn but do not wish to cause problems for cotton growers or want to abuse this powerful new insect control resource.

WHAT HAS BEEN DONE: Research and extension faculty in the College of Agriculture and Life Sciences at North Carolina State University have provided leadership in describing the relationship between Bt corn and Bt cotton in regard to resistance development in cotton bollworm (corn earworm) to the Bt toxin. Field, greenhouse and laboratory research was conducted on the relative bollworm mortality, growth rate of surviving caterpillars, egg laying of surviving moths, and other parameters when the insects were infesting Bt and non-Bt corn hybrids. These and other data found in the scientific literature were used to develop a wide-area stochastic computer simulation model of resistance development in cotton bollworm populations within a virtual corn, cotton and wild plant environment. The computer simulation model described resistance emergence patterns in bollworm if different percentages of Bt corn and Bt cotton were planted. Also, the spatial pattern of Bt and non-Bt corn and cotton was varied across the landscape and observed for effect on resistance development patterns. The relative importance of each of approximately 25 factors was studied for impact on the resistance development process. These simulations provided an improved understanding of Bt resistance development in bollworm and relationships between Bt corn and Bt cotton. The model indicated that planting ear-expressing Bt corn was important to Bt resistance development in bollworm, but that Bt corn could be planted at a moderate to high percentage depending on the amount of Bt cotton planted. This provided EPA with science-based support for decision making.

IMPACT: In early 1999 EPA announced that ear-expressing Bt corn could be grown on up to 50 percent of the acreage in the Cotton Belt, including North Carolina. The project served as a model for how insect resistance management issues relating to transgenic crops in a multiple crop system may be addressed by scientists, EPA, corporations and growers. Bt transgenic plants represent a valuable resource for managing insects and reducing insecticide in the environment. Science-based decisions provide the best hope for preserving this technology and assuring a long and useful life for this pest-management technology.

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MONITORING Bt RESISTANCE

ISSUE: The biological insecticide Bt is of great importance to agriculture because it is highly toxic to the pests of crops like cotton, corn and vegetables but is not toxic to other insects, wildlife or humans. Bt is a first of its kind, new-generation pesticide that has produced a new standard of insecticide safety. Yet as is the case with other insecticides, insects can develop resistance to Bt. And if the development of resistance is widespread, farmers could lose this powerful crop protection tool. Indeed, the development by insects of resistance to any pesticide often results in crop damage and can cause substantial economic losses to farmers. Pesticide resistance also increases the cost to government and industry of developing new pest control agents and increases the cost to consumers of agricultural products. Insect resistance to pesticides also results in more insecticide use and more insecticides in the environment.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University have developed a novel feeding disruption assay kit for monitoring resistance to the biological insecticide Bt. The assay technology to detect resistance to Bt has been granted a patent and is under commercial development in cooperation with Agdia Inc. of Elkhart, Indiana. The core technology has recently been expanded to include novel insect feeding systems and automated microbioassays for industrial screening and insecticide discovery.

IMPACT: The feeding disruption assay provides an early warning system for the detection of insect resistance to the insecticide Bt. The use of this assay kit as part of crop management will help maintain the efficacy of Bt in future insect control. In addition, the assay is also applicable to monitoring resistance to other insecticides, can potentially change insect rearing as we know it today and can be used in new insecticide discovery.

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EFFICIENCY AND FOREST PRODUCTS

ISSUE: Most of North Carolina's 2,000 forest products manufacturers are small and independently owned. In an increasingly global economy, these manufacturers need to increase their competitiveness by increasing efficiency.

WHAT HAS BEEN DONE: North Carolina State University's wood products extension team provides educational and technical assistance related to wood products assembly, processing and distribution for managers and other key personnel.

IMPACT: As a result of these efforts, a number of manufacturing firms have reported dramatic improvements. For example, a hardwood lumber manufacturer indicated annual savings of $400,000 in wood costs after training related to lumber grading rules. A furniture parts manufacturer implemented yield measurement methods that save $160,000 a year in its rough mill operation. One sawmill saved $950,000 a year upon adopting Extension-recommended monitoring procedures to identify yield losses; another reported $220,000 in annual savings by changing their material flow; and a third reported annual savings of $500,000 after following Extension's advice against investing in a large capital expansion project that would have led to negative cash flow for five years. These five examples, representing savings of $2.23 million, are just a few of the impacts information provided by wood products extension agents has had on North Carolina's forest products sector.

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MANAGING THE CEREAL LEAF BEETLE

ISSUE: The cereal leaf beetle, *Oulema melanopus*, is a pest of wheat and other cereal grains. Originally from Europe, this insect was introduced into the United States. It was first seen in North Carolina about 15 years ago. For the first 5 to 7 years the beetle was found in North Carolina wheat fields, it did little damage. Then, however, populations of larvae began to increase rapidly, first in Piedmont fields but later across the Coastal Plain. The larvae of cereal leaf beetle feeds on green leaves of wheat, oat and barley plants. Heavily infested fields may lose essentially all of the green leaf tissue, which reduces the grain yield. Grains growers responded to the increasing number of the insects by spraying fields with insecticide.

Initial research suggested that scouting for large larvae on the leaves could be done to give growers a guide as to when fields should be sprayed. Preliminary thresholds were developed telling growers when to spray. However, growers were increasingly dissatisfied with the results that this system produced. Damage increased in spite of their efforts.

WHAT HAS BEEN DONE: Cereal leaf beetle is a pest in the entire mid-Atlantic region. A research proposal was jointly developed by faculty at North Carolina State University and Virginia Polytechnic Institute and State University. It was submitted to the North Carolina Small Grains Growers Association and the Virginia Small Grains Board. The growers' organizations agreed to fund jointly a Ph.D. student project devoted to research on the life history of cereal leaf beetle and the effects of feeding damage on the wheat plant. Research was conducted on research stations and farmer fields in North Carolina and Virginia.

IMPACT: New early scouting procedures were developed that focused on looking for cereal leaf beetle eggs and young larvae, based on a narrow leaf stage range of plant growth. This allowed detection of treatable insect populations before damage was done to the crop — long before what was possible using the old procedure. New insecticide recommendations were provided by the North Carolina Cooperative Extension Service. As a result, growers greatly reduced the number of insecticide applications and use very low rates of insecticide when fields are treated. As a result of this effort to train growers to recognize and deal with this insect, the cereal leaf beetle is no longer the pressing problem it once was for many mid-Atlantic small grain growers.

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HELPING FARMERS USE HERBICIDES WISELY

ISSUE: Farmers who use herbicides wisely can save money and reduce the possibility of environmental damage from an herbicide application.

WHAT HAS BEEN DONE: Researchers at North Carolina State University created computer programs designed to help farmers decide whether they need to use herbicides. The programs also help farmers select the correct herbicide or combination of herbicides to control the weeds in their fields. The programs, called HADSS, HERB, and Pocket HERB, use economic thresholds to help farmers decide whether they need to use herbicides. If the damage weeds are likely to cause will cost less than the herbicide application, the application may be unnecessary. HERB and Pocket Herb are decision-support models designed to help farmers make postemergent weed management decisions. HERB runs on DOS-based desktop and handheld computers, while Pocket HERB runs on Windows CE palm-top computers. HADSS, a Windows system, is an expanded version of HERB that advises farmers on preemergent and preplant incorporated herbicide applications as well as postemergent applications.

In addition to herbicide application support, the programs provide an economic analysis comparing the likely results of acceptable herbicide treatments and the likely result if the farmer takes no action. Users may also sort treatments by control of a particular weed species or overall treatment efficacy, if maximizing control of a troublesome weed is more important in a given field than is maximizing economic return.

The programs make recommendations for corn, soybeans and peanuts. A version for cotton is currently being field tested. Versions have been developed for use in Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Ontario, Canada.

IMPACT: HADSS and HERB are helping farmers use herbicides wisely. The programs are used by extension personnel growers and private consultants in North Carolina, Georgia, Mississippi and Ontario, Canada. They are used in classes to demonstrate important principles of weed management. Field trials have shown that the programs can bring weed science expertise to the farm in a dynamic, easily usable and field specific format.

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CLEANING UP A WATERSHED

ISSUE: People living in the Long Creek Watershed in Gaston County had become concerned about the levels of sediment, nutrients and other contaminants in the creeks and tributaries of the watershed, which is adjacent to Charlotte and its population of
1 million people.

WHAT HAS BEEN DONE: The North Carolina Cooperative Extension Service in the College of Agriculture and Life Sciences at North Carolina State University has played a lead role in an effort involving more than 15 local, state and federal agencies to clean up watershed. Begun in 1992, this effort has focused on solving pollution problems, demonstrating and evaluating new technologies, and educating citizens on how to protect local streams. North Carolina State University faculty members and North Carolina Cooperative Extension Service agents have been instrumental in an educational process that provides research-based knowledge to improve water quality. Riparian buffers, urban stormwater treatments and animal waste management systems are key elements in achieving this goal.

IMPACT: Water quality monitoring indicates that bacteria, nutrient and sediment concentrations have been reduced by as much as 90 percent in the waters of the Long Creek Watershed.

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GIVING GARDEN, LANDSCAPE ADVICE

ISSUE: North Carolina Cooperative Extension agents with consumer horticulture responsibility often find it difficult to meet an overwhelming demand for home gardening information in a timely manner.

WHAT HAS BEEN DONE: To meet the demand, agents recruit and train volunteer staffs through the Master Gardener Volunteer Program. These volunteers receive guidance, support and training materials from North Carolina State University's College of Agriculture and Life Sciences and, in turn, provide research-based home horticulture information to homeowners, garden clubs, civic groups, school children and others.

IMPACT: In 1998 alone, more than 2,200 Master Gardener Volunteers provided 117,541 hours — the equivalent of what 61 full-time employees could provide — of educational assistance to 445,000 North Carolina residents. Highly-trained Master Gardener Volunteers now respond to the vast majority of home landscape and garden telephone calls in the urban centers of North Carolina.

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PROTECTING TEENAGERS

ISSUE: The National Institute for Occupational Safety and Health estimates that more than 21,000 teenagers sustain work-related injuries and illnesses that result in lost work days, and that 64,000 teenagers are treated for work-related injuries in emergency departments annually.

WHAT HAS BEEN DONE: A team composed of researchers from North Carolina State University's College of Agriculture and Life Sciences and the University of North Carolina's School of Public Health interviewed hundreds of North Carolina young people about workplace injuries. They found that more than half of working teens had suffered workplace injuries, and two-thirds reported using dangerous or illegal equipment. Most perceived their jobs as dangerous, and yet nearly half had received no on-the-job safety training.

IMPACT: Building on this research, groups in Massachusetts, California, West Virginia, Pennsylvania and North Carolina have developed safety training programs for teen workers. Nationwide, the study has been used to inform policies and programs for injury surveillance and the reduction of occupational injuries.

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ASSESSING HEART DISEASE RISK

ISSUE: Risk assessment is an important step in heart-disease management. For years, physicians have monitored blood cholesterol levels to assess risk of coronary heart disease. They measure patients' total cholesterol and the amount of cholesterol in the high-density lipoproteins (HDL) and low-density lipoproteins (LDL). The problem is that HDL and LDL consist of several subclasses that differ in their associations with coronary heart disease. People with the same cholesterol levels but different lipoprotein subclass distributions can have very different heart-disease risks. Until now, doctors could not apply this knowledge because they lacked efficient, inexpensive laboratory methods to measure these subclasses.

WHAT HAS BEEN DONE: A scientist in the College of Agriculture and Life Sciences at North Carolina State University has devised a method using nuclear magnetic resonance technology to measure human blood lipoproteins. The method is the first to allow direct simultaneous measurement of the various lipoprotein particles that determine heart disease. This method produces a complete blood lipoprotein profile (NMR LipoProfile) in less than a minute, automatically. Clinical studies have demonstrated that the subclass information significantly enhances the prediction of coronary heart disease compared to the standard cholesterol risk factors.

IMPACT: The nuclear magnetic resonance technology greatly improves the assessment of heart-disease risk by giving a clearer picture of a person's lipoprotein makeup. The measurement process is rapid and efficient, making it cost-effective and clinically accessible. Recent commercialization of the technology has made NMR Lipoprofile testing available to physicians nationally, enabling improved clinical decision making about diet, exercise and drug therapy.

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CARING FOR SCHOOL-AGE CHILDREN

ISSUE: In nearly 80 percent of North Carolina families with school-age children, both parents work. A needs assessment showed that these parents find it a challenge to locate high-quality, adult-supervised programs for their children to take part in during the after-school hours when the parents are working. Single parents who work faced a similar dilemma.

WHAT HAS BEEN DONE: With a grant of $1.7 million, North Carolina State University's College of Agriculture and Life Sciences launched an initiative aimed at helping communities make high-quality after-school care more widely available. North Carolina Cooperative Extension agents and professionals from more than one-quarter of the state's counties — those with the greatest documented need — received training and funds to create new programs or expand and improve existing ones.

IMPACT: Child care programs for school-age children were expanded to accommodate 2,000 children in 26 counties after school, on teacher workdays and holidays and during the summer. Research has shown that participating children improved their academic performance, were better able to cope with negative peer pressure and had lower rates of teen pregnancy and alcohol and drug use than their non-enrolled peers. Meanwhile, with these new child-care options, parents were able to reduce the number of days they missed at work. And more than 130 new jobs were created.

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FOOD SAFETY INFORMATION

ISSUE: Food safety continues to be an important health and economic issue. It is estimated that foodborne diseases cause approximately 76 million illnesses, 325,000 hospitalizations and 5,000 deaths annually in the United States. The total estimated cost of dealing with foodborne disease is more than $5 billion a year. Food scientists know what it takes to make food safe, but busy consumers can find it daunting to get the food safety information they need.

WHAT HAS BEEN DONE: An easy-to-use, layman's language Internet site — a gateway to food safety materials from all over the world — was developed by North Carolina Cooperative Extension Service specialists in the College of Agriculture and Life Sciences at North Carolina State University. In addition to food-safety information, the site contains links to more than 600 other food-safety-related Web pages. The site's Web address is: http://www.ces.ncsu.edu/depts/foodsci/agentinfo.

IMPACT: The Web site averages more than 2,000 hits per day and has been listed among the top 10 Web sites for nutrition information by USA Today. The site was ranked among the top six reviewed by a review panel from Tufts University, earning perfect scores for timeliness, accuracy and depth of information. When Hurricane Floyd hit the North Carolina coast in August 1998, the site provided food-safety information on what to do after a natural disaster strikes. As a result, the site received more than 40,000 visits in just one day. The site receives food safety inquiries almost daily from all over the world.

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ENSURING FOOD SAFETY

ISSUE: With the beginning of the year 2000, all meat and poultry processing plants with fewer than 10 employees and less than $2.5 million in sales were required to meet federally mandated provisions related to hazard analysis and critical control point systems. But many managers of small meat processing plants said that spending significant time away from the job to undergo necessary HACCP training would result in serious economic hardship.

WHAT HAS BEEN DONE: Extension food-science specialists from the College of Agriculture and Life Sciences at North Carolina State University worked in partnership with the North Carolina Department of Agriculture and Consumer Services to provide a series of training opportunities that required no overnight travel and only intermittent absences for participants. They offered the three-day training course one day a week for three consecutive weeks at seven locations across the state. They also assembled a workbook that allowed participants to take the knowledge they gained from each class, apply it to their plants between sessions and return to class with any questions that arose.

IMPACT: The novel approach to training allowed 232 processors representing 161 small plants to undergo training in HACCP principles. By the course's end, most had developed viable plans that enabled them to meet the federal requirements, to more effectively control the safety of their products and thus continue to contribute to their communities' economy.

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PROMOTING SAFE FOOD HANDLING

ISSUE: An estimated 44 percent of all reported cases of foodborne illness are due to improper food-handling at restaurants and other food-service operations. And it is projected that each restaurant-related foodborne illness outbreak costs an average of $75,000. In North Carolina, there are more than 25,000 food-service establishments employing nearly a quarter-million food handlers, making food service the second largest retail employer in North Carolina. The industry is characterized by high turnover and lack of training, which contribute to improper food handling.

WHAT HAS BEEN DONE: As part of the ServSafe training program offered by the College of Agriculture and Life Sciences at North Carolina State University, Cooperative Extension agents work hand-in-hand with county environmental health specialists to provide food-safety training for food-service managers.

IMPACT: According to pre- and post-tests conducted as part of the 18-hour ServSafe training program, 2,410 food-service workers in 37 counties adopted safer food-handling practices. Such practices have been proven to lessen the potential for foodborne illness.

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REMOVING METALS FROM WASTE

ISSUE: The accumulation of copper and zinc in fields that have received repeated application of swine wastewater is of concern because of the toxicity of these metals to plants. Currently, there is no effective way to remove the metals from swine
wastewater.

WHAT HAS BEEN DONE: Scientists in the College of Agriculture and Life Sciences at North Carolina State University have shown that the fungus *Aspergillus niger* can remove 85 percent of the copper and 89 percent of the zinc from treated swine wastewater.

IMPACT: The identification of a fungus that can remove high levels of copper and zinc from wastewater may provide new approaches to lessen the impact of swine waste on the environment. Two strategies may be possible. It may be possible to immobilize the fungus on a substrate and use it as a biofilter to remove the metals. Or the protein in the fungus that is involved in copper and zinc removal could be purified and used to bind the two metals.

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DISPOSING OF DEAD ANIMALS

ISSUE: For many years, disposing of animal carcasses has been a problem for North Carolina's huge poultry and swine industries. Current methods have drawbacks such as high expense, potential for disease spread and waste of valuable nutrients.

WHAT HAS BEEN DONE: Researchers in the College of Agriculture and Life Sciences at North Carolina State University have created a better method of disposing of dead animals. Researchers designed a machine that grinds up animal carcasses while adding either carbohydrates and bacteria to ferment the resulting material or phosphoric acid to preserve the material. The material then may be kept on a farm until it is convenient to pick it up. The technology allows for the capture and recycling of the nutrients in carcasses. North Carolina State University has patented the technology and licensed it to a company that is building the machines. Because the technology preprocesses carcasses on the farm, central processing facilities probably will be smaller and more environmentally friendly than a rendering plant.

IMPACT: Four farmers have installed the technology on farms as test units and report favorable results. Installation of more than 100 machines is pending the completion of a central processing center. More than 200 poultry and swine farmers have requested information on the mortality preservation system. About seven groups are interested in building a plant to process mortality silage into feed ingredients, fish feed and pet food. Negotiations are under way to build at least three processing plants in North Carolina, one in Missouri, one in Utah and one in Colorado.

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HELPING TURKEYS HATCH

ISSUE: Modern turkey breeding techniques pose a challenge for the industry. In recent years, the emphasis has been on speeding the growth of muscle mass, often to the detriment of the embryos' other developing organ systems. This means that although an embryo has the muscles to break through its shell, its life-sustaining organs are less mature than they should be, making it more likely to die or grow more slowly.

WHAT HAS BEEN DONE: Researchers in the College of Agriculture and Life Sciences at North Carolina State University have found that adding a tiny amount of iodine — a naturally occurring component of thyroid hormones — to a female turkey's feed can boost the number of eggs that hatch successfully and promote healthier, faster growing young birds. A research team produced a 4.2 percent increase in hatching rates — a tenfold improvement over old standards — by adding just four parts per million of iodine to breeder hens' feed. The iodine-enriched diet also resulted in a 50 percent improvement in post-hatching survival rates and significantly faster growth after that, especially from the sixth day on.

IMPACT: The cost to producers of feeding breeder hens an iodine-enriched diet is just a few cents per ton of feed, but the financial payoff can be substantial. Based on U.S. Department of Agriculture national production figures of between 300 million and 360 million young poults a year, growers could save $17 million a year in reduced mortalities. And that doesn't account for any increased profits they would see from reducing turnaround time — the number of days it takes to raise turkeys to market size.

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PROTECTING POULTRY

ISSUE: During the mid-1990s, a poorly understood illness devastated turkey farms in North Carolina and neighboring states. Poult enteritis mortality syndrome strikes quickly: Poults stop eating and drinking and rapidly lose weight. A grower can lose an average of 20 percent of the flock within a week, and a loss of 50 to 60 percent is not unusual. PEMS hit particularly hard in North Carolina, where turkey production is a $470 million industry. In just one year, it cost producers $15 million, and companies began cancelling contracts with growers.

WHAT HAS BEEN DONE: In cooperation with the turkey industry, poultry science and veterinary medicine faculty at North Carolina State University developed an educational and biosecurity monitoring program to combat PEMS. Growers were encouraged to control traffic onto their farms, provide adequate ventilation, minimize disease spread by boots and clothing, lower pest and rodent populations in their facilities, and keep wild birds away from poults. Meanwhile, researchers continue their efforts to identify the virus that causes the syndrome and have developed a diagnostic tool to identify the presence of one possible culprit.

IMPACT: Producers using the university-developed biosecurity program cut their incidence of PEMS and the related corona virus significantly, allowing them to increase yields. Some also reported that they used less medication on their flocks. In fact, one integrator, as the company's that contract with growers to produce poultry are known, reported reduced medication costs among the company's growers of 0.6 cents per pound — which translates into an annual savings to the company of $2.1 million.

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SALMONELLA-FREE EGGS

ISSUE: Fresh eggs can be contaminated with *Salmonella enteritidis*, a microorganism proven to sicken people.

WHAT HAS BEEN DONE: Researchers in the College of Agriculture and Life Sciences at North Carolina State University have developed a low-temperature, long-time-water immersion heat treatment that produces salmonella-free eggs.

IMPACT: Salmonella-free eggs may be used to make safe soft-boiled, soft-poached or sunny-side-up fried eggs. Such pasteurized eggs may also be used safely in custards, Caesar salad dressing, ice cream, eggnog and sauces such as hollandaise sauce. Eggs processed using this technology were first test marketed in 1996. Michael Foods of Minneapolis is now using the technology in a Nebraska egg processing plant, which has an annual production capacity of 2.5 million dozen eggs. Eggs from this plant are being sold in Minnesota, South Dakota and Wisconsin. Based on the original research done at North Carolina State University, the egg pasteuriaiton process received official U.S. Food and Drug Administration approval April 1, 1999. The process was noted in a report produced by the President's Council on Food Safety as a viable processing option for assuring the safety of eggs. Additional marketing opportunities for pasteurized eggs are anticipated in the near future pending the approval of the product by two fast food chains. On the international front, Michael Foods is seeking to establish a joint venture with a European Union egg producer and processor to begin marketing pasteurized eggs to a major European Union supermarket chain.

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MANAGING POULTRY LITTER

ISSUE: With the beginning of the year 2000, owners and operators of dry waste poultry farms in North Carolina were required by state law to have developed and implemented a poultry dry litter management plan designed to prevent nitrogen run-off into water supplies.

WHAT HAS BEEN DONE: A Poultry Coordinating Committee in the College of Agriculture and Life Sciences at North Carolina State University developed a nutrient management plan workbook that tells growers how to take used litter from poultry houses, get a nutrient analysis and track where the litter goes once it's applied as a crop nutrient. Initially, more than 150 Extension agents, poultry company personnel and others were trained to help growers develop nutrient management plans. In turn, these trainers led workshops for more than 4,000 growers representing all North Carolina's integrated poultry companies. These growers produce about 1 million tons of poultry litter per year.

IMPACT: The training not only helped growers comply with state regulations aimed at keeping nitrogen and other potentially polluting nutrients out of ground and surface waters, it also helped producers turn a waste product into a valuable crop nutrient. The training workbook developed at North Carolina State University is being used as a model by more than 12 other states.

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CHICKENS AS CANCER MODEL

ISSUE: Ovarian cancer is a deadly disease that kills more women than all other gynecological cancers combined. Each year in the United States, 27,000 to 28,000 woman are diagnosed with the disease, and 16,000 to 17,000 women die from it. Despite progress made in treating cancers, most women who contract ovarian cancer will die from it. The disease is not easily detected and is often discovered in an advanced stage.

WHAT HAS BEEN DONE: Researchers at North Carolina State University and Duke University discovered that egg-laying chickens are effective models for studying ovarian cancer because of their high rate of naturally occurring ovarian cancer. A two-year study showed that chickens are a suitable model for the study of ovarian cancer prevention. The epithelial, or surface, cells of chicken ovaries are similar to those of human ovaries, and ovarian tissues in chickens respond to the hormone progestin the same way that human ovaries do. By treating the chickens with different regimens of progestins, like those found in human birth control pills, researchers hope to learn which therapies most effectively prevent ovarian cancer.

IMPACT: This research has provided a model for developing therapies to prevent a deadly human cancer and save lives.

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COOLING EGGS

ISSUE: As consumers have become more aware of food-safety issues, producers have been challenged to find new ways of ensuring that their products are the safest, highest quality that money can buy. Cooling eggs rapidly after they are laid is one way to ensure quality and a longer shelf life. But with traditional refrigeration methods, it can take seven to 10 days to reduce the internal temperature of eggs to 45 degrees F., the storage temperature required by the U.S. Department of Agriculture.

WHAT HAS BEEN DONE: Researchers at North Carolina State University have developed a system for cooling eggs cryogenically that dramatically reduces cooling time. Eggs are first graded, washed and placed in cartons. Then in only 90 seconds, they pass through a 15-foot-long cooler filled with carbon dioxide gas at a constant temperature of minus 75 degrees F. This process reduces cooling time to a matter of minutes.

IMPACT: By rapidly cooling eggs, producers can further reduce consumers' risk of contracting *Salmonella enteritidis* from eggs. In addition, the process increases the shelf life of eggs from the typical 28 days to 60 days, which increases opportunities for exporting eggs and reduces producers refrigeration costs while enhancing the overall egg quality. The rapid cooling technology is expected to be commercially available in the summer of 2000, following tests at a North Carolina egg processing facility.

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MAKING SEA SCALLOP MEDALLIONS

ISSUE: A large portion of the scallops processed in North Carolina are smaller than desirable market size. Existing technology to create larger meat products from smaller parts requires that the products be cooked or frozen, but consumers prefer raw, refrigerated seafood.

WHAT HAS BEEN DONE: Food scientists with the North Carolina Cooperative Extension Service in the College of Agriculture and Life Sciences at North Carolina State University found a way to use a beef plasma extract to bind small sea scallops to create uniform medallions that are one-inch in diameter or larger. The medallions can be packaged fresh so that they appeal to grocery shoppers and restaurant owners who prefer fresh seafood over frozen or pre-cooked food.

IMPACT: Several seafood processors are using the North Carolina State University technology, including one North Carolina seafood processor that has expanded its business by 20 percent by making and selling the sea scallop medallions to food distributors and food services, retail chains and grocery clubs throughout the United States and Europe. The medallions are worth double what the smaller scallops bring in, and yet they represent a better value than single scallops of the same size. The processor can also ensure a consistent quality, shape and size, which is important to the food industry.

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RAISING HEALTHIER CATTLE

ISSUE: North Carolina, indeed, the entire Southeastern United States, has developed a reputation for producing sickly feeder cattle. As a result, feedlots tend to pay less for feeder cattle from this region.

WHAT HAS BEEN DONE: North Carolina Cooperative Extension Service specialists and agents in the College of Agriculture and Life Sciences at North Carolina State University developed the North Carolina Certified Beef Production Program. The program promotes animal health by training certifiers who must verify that cattle producers have followed prescribed quality assurance practices designed to promote animal health. The program includes recommendations for practices such as weaning, feeding, vaccination and parasite control. It includes 138 certifiers, while 720 North Carolina cattle producers passed an exam and have been enrolled as certified beef producers.

IMPACT: The program is relatively new, and it is still to early to measure its economic impact across North Carolina. However, one element of the program, a calf preconditioning program, has been in place for several years and provides an indication of the potential for the statewide program. The preconditioning program covers just a five-county area. Producers in this area sell close to 700 calves annually. The preconditioned calves sell for roughly $40 more each than calves from producers not active in the program. The program, therefore, is putting close to $28,000 into the pockets of producers annually.

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PROTECTING FERMENTATION

ISSUE: The growth and metabolic activities of bacterial cultures are vital in the making of foods such as cheese as well as proteins, enzymes, pharmaceuticals and chemicals. However, many bacterial cultures are susceptible to attack by bacterial viruses. Such attacks can lead to product losses, safety concerns and spoilage of raw materials.

WHAT HAS BEEN DONE: A novel system to defend bacteria from viruses has been developed in the College of Agriculture and Life Sciences at North Carolina State University. It is designed to trap, destroy and eliminate new bacterial viruses as soon as they appear in fermentation environments. The system relies on alternating different natural defense systems inside a bioprocessing culture and rotating the use of those derivatives in the fermentation plant. Because the external structures of the bacterium remain the same, the virus is tricked to attach and infect only to find inside a completely different defense that either kills the phage or prevents its replication. The process allows the continuous use of one superior bacterial strain type for its fermentation or bioprocessing properties, changing only the internal bacteriophage defenses such that any new phages are trapped and destroyed by the defenses that are internally rotated.

IMPACT: The system can be applied to virtually any bacterium that is susceptible to attack by bacteriophages and thus is widely applicable across the food biotechnology and bioprocessing industries. The cultured dairy product industry has already implemented this system for the manufacture of cottage cheese and hard cheeses in some plants in North America. Rhodia Inc. of Madison, Wisconsin, has licensed the technology and is currently implementing and evaluating its use in dairy starter culture systems.

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NUTRITIONAL WELL-BEING

ISSUE: The nutritional well being of older adults is an important health issue. Often, eating habits of a lifetime must be changed in order to improve the health and well being of aging adults.

WHAT HAS BEEN DONE: In an effort to improve the nutritional habits of older adults and reduce malnutrition, North Carolina Cooperative Extension agents in Rutherford County made available a Partners In Wellness Program. During a six-month period, 71 older adults in Rutherford County participated in 16 weekly sessions. The program focused on nutrition-related issues unique to limited resource audiences age 65 and older.

IMPACT: In random selection personal interviews of program participants, all the interviewees said they made lifestyle changes that positively affecting their diet and appetite. They reported improving their diets by eating more fruits and vegetables, and all the interviewees stated they had adopted a new tracking system that helped them better manage their medications, resulting in fewer side effects and drug interactions.

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SEEKING CONCENSUS ON NATURAL RESOURCES ISSUES

ISSUE: People often disagree over how land, air and water resources should be used and managed. Natural resources policy gridlock can result if decision making moves from the meeting room to the courtroom.

WHAT HAS BEEN DONE: The Natural Resources Leadership Institute was created by the North Carolina Cooperative Extension Service in the College of Agriculture and Life Sciences at North Carolina State Universtiy to improve the management of natural resources in North Carolina and to enhance rural economic development while improving environmental quality.

The institute's Leadership Development Program brings together people from the public and private sectors and teaches them the leadership skills needed to resolve natural resource issues and develop resource management policies. The curriculum focuses on leadership development, conflict resolution and collaborative problem solving and includes a practicum that involves the participant in developing collaborative solutions to natural resource issues.

The institute also provides negotiation, facilitation and mediation services designed to manage conflict over environmental issues and to aid collaborative decision making. The institute convenes and facilitates dispute resolution processes in limited resource communities and around issues where funding is problematic or unavailable.

The institute provides specialized training on subjects such as leadership, environmental conflict resolution, public involvement and participatory decision making to agencies, boards and commissions, nonprofit organizations, businesses and interested citizens. The Institute organizes and convenes policy and problem solving forums around important environmental issues. Forums are designed to bring together representatives of business, public interest groups and government to jointly explore public policy issues, budget priorities, future visions or regulatory matters.

IMPACT: Program graduates are working to develop solutions to natural resource problems. For example, graduates worked together to establish a regional council of leaders that is addressing water pollution in North Carolina's lower Cape Fear River basin. The council is generating options for addressing pollution in the river basin. Graduates also organized two forums for the Southern Center for Sustainable Forests. The forums brought together a diverse group of North Carolinians, who identified issues related to North Carolina forests and proposed actions the center might take to address these issues. The Institute is also conducting the public participation portion of a study being done by the Southern Center for Sustainable Forests on wood chip production in North Carolina.

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RESPONDING TO HURRICANE FLOYD

ISSUE: In September 1999, flooding caused by Hurricane Floyd, North Carolina's worst natural disaster in history, caused billions of dollars in damage to homes, businesses, crops and livestock operations in eastern North Carolina.

WHAT HAS BEEN DONE: Following the devastation, faculty in the College of Agriculture and Life Sciences at North Carolina State University offered their expertise and hands-on assistance to help the state recover from this disaster and restore a normal quality of life for the state's citizens. These are some of their efforts:

- Many thousands of livestock drowned in the floods, including cows, swine and poultry. The college's Cooperative Extension staff based in the counties offered hands-on assistance in the disposal of dead livestock in order to prevent the spread of disease. Entomologists provided recommendations on controlling insect pests spawned by dead livestock and advised beekeepers on how to protect their hives in the midst of widespread aerial spraying.
- Cooperative Extension also assisted farmers who needed to reach their operations to feed livestock that survived. After the initial crisis, extension agents organized a feed and hay lift to provide donated feed for livestock in Eastern North Carolina. Many feed supplies and pastures were damaged, leaving farmers unable to feed their livestock.
- With many crops underwater for days, college researchers and extension specialists inspected fields and offered recommendations on how farmers could salvage crops.
- Family and consumer sciences faculty offered tips on cleaning up homes and businesses after the flood. Through television programs, collaborative training with

IMPACT:

- Damage to the state's beekeeping industry, which is critical to production of some crops, was minimal, thanks to advice on spraying provided by entomologists. Thousands of drowned poultry, swine and cattle were buried or incinerated.
- The extension hay lift provided 178 truckloads of hay to flood-affected counties in the eastern part of the state.
- Residents and volunteers are continuing the long-term task of cleaning and rebuilding their homes and lives, with the help of research-based information from the college.
- Because little federal aid is available to farmers, donations raised through the college are being used as direct payments to help farmers in flooded counties. Committees in each county examine the needs and award grants from the fund, up to $4,000 for farmers hit hardest by the floods.

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HEALTHY HEARTS

ISSUE: Heart disease is a major cause of death. Maintaining healthy lifestyles and eating habits has been shown to help prevent or delay the onset of heart disease.

WHAT HAS BEEN DONE: North Carolina Cooperative Extension agents in Craven County graduated 180 participants from two 12-week Give Your Heart A Healthy Beat! programs.

IMPACT: Evaluations showed that 95 percent of the participants felt they gained knowledge that will help them make healthier food and lifestyle choices, 104 were able to reduce their blood cholesterol, blood pressure, or both, and 125 reduced their weight. One hundred fifty two participants indicated they had adopted a regular exercise program.

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WATCHING THEIR WEIGHT

ISSUE: To maintain optimal health and fitness, the weight of military personnel is closely monitored. Air Force officials contacted the North Carolina Cooperative Extension in Buncombe County when 15 men stationed in the county exceeded weight limits.

WHAT HAS BEEN DONE: Ten classes were conducted in Buncombe County over a 12-week period. Participants learned about good nutrition, proper diet and exercise.

IMPACT: The men were closely monitored for dietary recalls and were counseled each week. After the 12 weeks, all had achieved their weight loss goals. In a follow-up conference with the wellness coordinator they reported it was the best weight loss program they had ever participated in and requested another class in three months to help keep them on track.

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UNDERSTANDING SOY

ISSUE: Eating soy foods may help to reduce the risk of heart disease, which is a major cause of death in North Carolina, but many people do not cook with soy because they don't know how.

WHAT HAS BEEN DONE: North Carolina Cooperative Extension agents in Forsyth County, working with the county health department, the Wake Forest University School of Medicine and Lowe's Foods conducted three classes reaching 166 consumers in Forsyth County to help them understand the benefits of soy and how to cook with it.

IMPACT: A survey mailed 10 months after the classes to the 54 participants showed that 81 percent now use soy products at least once a week and 44 percent use soy products one to two times daily. Of those who have had their cholesterol checked since the class, 67 percent reported a reduced level. Since elevated cholesterol is a risk factor for heart disease, participants who are incorporating soy into their diets and reducing their cholesterol may be at reduced risk for heart disease.

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NUTRITION EDUCATION

ISSUE: Obesity is a risk factor for many diseases and medical conditions.

WHAT HAS BEEN DONE: Two multi-week weight loss classes focused on nutrition education to prevent obesity were held in Cherokee County.

IMPACT: Evaluations completed by participants revealed that 40 percent lost their goal weight. All said they increased their awareness of the need for good nutrition. All said that they increased their knowledge of factors that promote good health and that they either already were or would begin to apply that knowledge. All said they were aware of dietary guidelines, and 40 percent said they planned to adopt or continue to follow diets consistent with those guidelines.

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MORE FRUITS AND VEGETABLES

ISSUE: According to the American Cancer Society, a low-fat diet that includes at least five servings of fruits and vegetables a day can significantly reduce the risk of developing certain types of cancer.

WHAT HAS BEEN DONE: Although southerners tend to eat lots of fresh produce, it is often loaded with fat, salt and sugar. In an effort to reduce the incidence of cancer in Guilford County, eight Extension Homemakers were trained to present a workshop called "Southern Cookin' with 5-A-Day." The workshop program included information on reducing fat, salt and sugar and lower-fat alternatives to traditional ingredients and food-preparation methods.

IMPACT: One-hundred and four (96 percent) of the 108 program participants reported increasing their fruit and vegetable consumption and adopting healthier preparation methods as a result of the information provided during workshops.

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