

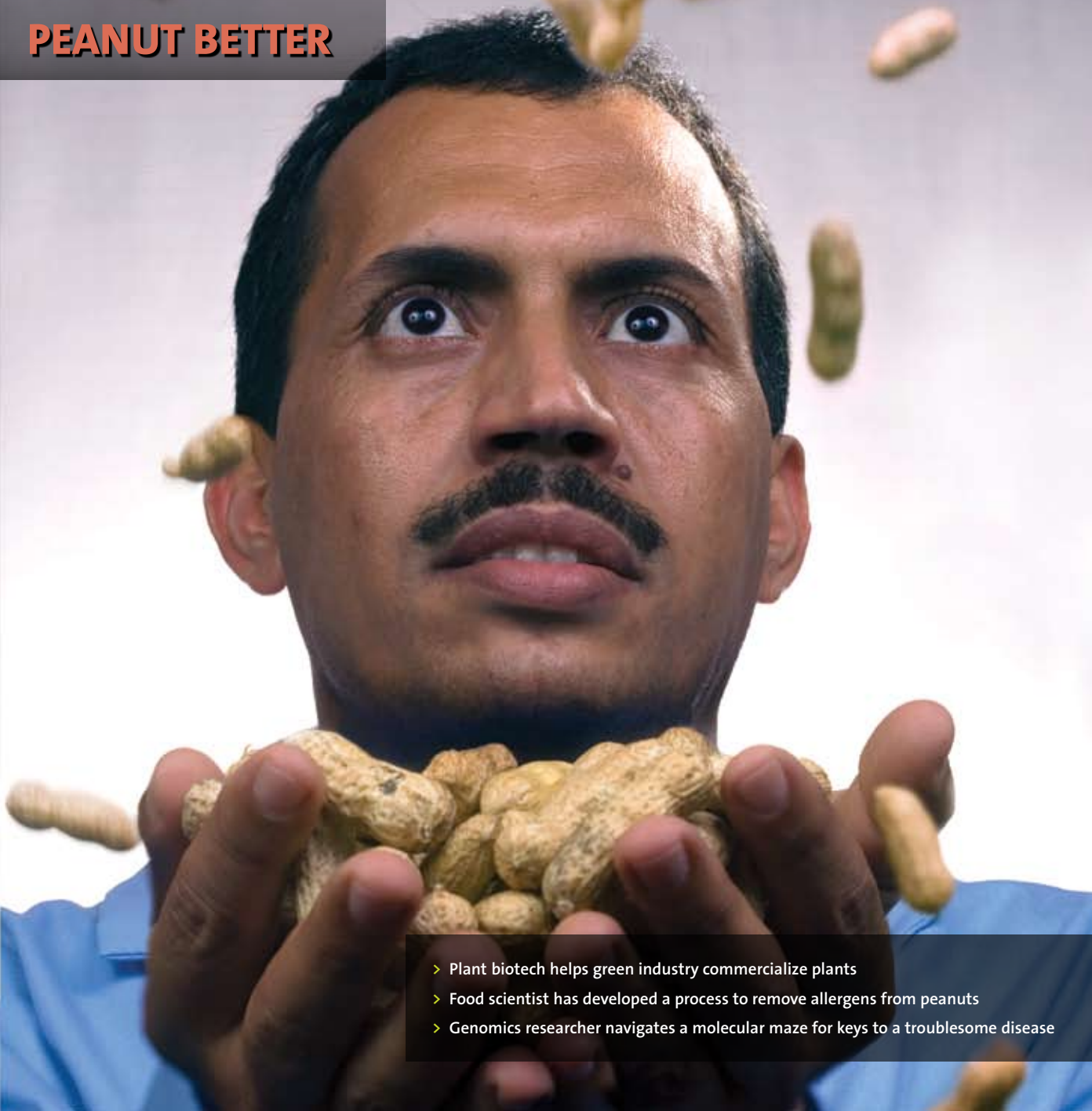


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AT NORTH CAROLINA AGRICULTURAL
AND TECHNICAL STATE UNIVERSITY

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Re:search

PEANUT BETTER



- > Plant biotech helps green industry commercialize plants
- > Food scientist has developed a process to remove allergens from peanuts
- > Genomics researcher navigates a molecular maze for keys to a troublesome disease



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Researchers study childhood eating habits.



New packaging system for mushrooms

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Re:search

A magazine of the Agricultural Research Program in the School of
Agriculture and Environmental Sciences at North Carolina Agricultural and Technical State University

Vision

The School of Agriculture and Environmental Sciences shall be
a premier learner-centered community that develops and preserves
intellectual capital in the food, agricultural, family and environmental
sciences through interdisciplinary learning, discovery and engagement.

The School of Agriculture and Environmental Sciences provides
opportunities for individuals from diverse backgrounds to achieve
excellence in the food, agricultural, family and environmental sciences
through exemplary and integrative instruction, and through scholarly,
creative and effective research and Extension programs.

Mission

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Industry partnerships bring research to fruition



Dr. Carolyn Turner

Science is all about asking questions, and in the Agricultural Research Program at N.C. A&T State University, we frequently ask ourselves, "How can we ensure that the work we do in our laboratories improves the well-being of the farming community, families and consumers, the economy and the environment?"

As we all know, producing research findings alone does not guarantee benefits. However, bridging the gap between the laboratory bench and the grocery store shelf often requires more time and more resources than the research itself. While we work in concert with Cooperative Extension to ensure that the family, community and farming issues that we resolve are shared with the end user, we also rely on industry partners to translate our technical research into new or improved industrial processes or products. The strategic plan for the School of Agriculture and Environmental Sciences emphasizes this theme of partnerships, and keeps us on track in pursuit of them.

Fortunately, the Agricultural Research Program and the University's Office of Outreach and Technology Transfer are making progress in this direction. Several research projects in recent years have led to patents, and are now leading to promising business partnerships for the benefit of consumers and the economy. One example is our process to make allergen-free peanuts. Another is the development of a truffle-monitoring method last year, which, while not patented, has already given rise to a

new business to help growers minimize risk. A third is a new packaging technology that could increase shelf life of exotic mushrooms, and fourth is the University's first spin-off company — a biotech firm that will manufacture proteins for use in diagnosing and treating disease. Each of these success stories is highlighted in this issue of *Re:search*.

Other major partnership opportunities are under way. One of the most exciting is the new North Carolina Research Campus being developed in Kannapolis, N.C., slightly over an hour's drive from our campus, where we will have four laboratories in a building shared with three other major research universities. A satellite office is now open in Kannapolis and present plans call for occupying laboratories in 2008. This world-class research campus will focus on fruit and vegetable research. Our contribution will be in the area of post-harvest technologies, which will include finding ways to enhance nutrition, improve food safety and quality, and convert agricultural byproducts and waste into value-added products.

Another emerging partnership opportunity that you will hear more about in the future is the Food and Agricultural Products Research and Technology Center that is now being planned for the new Gateway University Research Park, which will be developed on a portion of the University Farm. Again, the aim here will be to merge research results with industry efforts.

So to answer our own question, we are finding that partnerships — developed either through Cooperative Extension or industry — are the key to making good use of the discoveries emerging from our Agricultural Research Program. We are beginning to see the fruits of our labor and we expect a greater yield in the future.

Dr. Chung Seo (left) and Dr. Mohamed Ahmedna are interim co-directors of the Center of Excellence for Post-Harvest Technologies, the SAES research unit at the North Carolina Research Campus in Kannapolis.



Controlling growth

Plant biotech helps green industry commercialize plants

■ A plant biotechnologist in the Agricultural Research Program is improving the production efficiency of two ornamental shrubs that have a history of being difficult or impossible to commercialize.

His work could result in new plants for one of the most important segments of North Carolina's agricultural economy — the nursery and greenhouse industries. Worth \$872 million annually, the segment is third only to broiler chickens (worth more than \$2.2 billion) and hogs (almost \$2.1 billion).

Dr. Guochen Yang is working with plant tissue culture and growth regulators to speed up the germination and growth rate of two flowering evergreen shrubs, which he sees as having untapped commercial potential as landscape ornamentals.

One of these, the pearlshrub (*Exochorda racemosa*) is a high-value but very slow-growing shrub that can wholesale for \$55 for a five-gallon plant. Another flowering evergreen — which is remaining unnamed while the University investigates its potential as intellectual property — has promise as a showy specimen plant for the home and business landscape, but is so hard to grow that it has never been commercially exploited. Yang is developing a protocol to dramatically speed up seed germination and growth rates, and has already had remarkable success with germination. He has developed a technique that achieves almost 100 percent germination in as little as 10 days to two months, compared to 18 months and 20 percent germination rate under conventional planting methods.

"In the horticulture industry time is money," he said.

Another success with pearlshrub illustrates just how effective plant biotechnology

can be: Under Yang's new protocol, it takes two to three years to grow a five-gallon container bush, compared to five years using conventional methods.

Yang explained that because tissue-culture laboratories save time, labor and space, they are increasingly important in the nursery business. Chemicals speed the rate of seed germination, or, alternatively, they enable many new plants to be produced from

tiny amounts of parent plant material. For instance, a cutting from a stem, leaf or root that is just one quarter-inch long can be induced to produce hundreds of tiny shoots inside a test tube or Petri dish in just a few days. Instead of taking up acres of greenhouse space, thousands of shoots can be maintained in a space the size of a small closet until they are ready to be planted in soil.

But before that can take place, research has to first define the production protocols, and it can take several years of experimentation on a single plant before hitting on the right combination of growth regulators and hormones. However, once that protocol is established, productivity skyrockets and growers can benefit from that research for many years.

"Plant biotech has several advantages, it enables you to mass produce plants very quickly, and gives you much more control over the growing cycle," Yang said.



Dr. Guochen Yang at the SAES's Reid Greenhouse.

Peanut Better

Food scientist has developed a process to inactivate allergens in peanuts

■ Dr. Mohamed Ahmedna would like to see a day when every child — allergic or not — can enjoy a healthy, nutritious peanut butter sandwich. That day might arrive sooner instead of later, thanks to a process that he has perfected to inactivate allergens in peanuts.

The patent-protected process involves treating the whole kernels with a food-grade solution that does not alter the taste, aroma or texture of the kernel. Several food companies are showing interest in the new process, according to Doug Speight, associate dean for Outreach and Technology Transfer at N.C. A&T.

The processed peanuts still have to undergo animal and human testing, but laboratory tests using immunoassays have confirmed 100 percent inactivation of the two worst allergens in peanuts, known as Ara h1 and Ara h2.

Peanut allergies are considered to be one of the most dangerous food allergies, afflicting millions of Americans and causing approximately 100 - 150 deaths and many more hospitalizations each year from anaphylactic shock.

“We are pleased to have developed a method to render this nutritious food safer for allergic individuals,” Ahmedna said.

Ahmedna’s process is expected to add value to a crop that is already economically and nutritionally important. Peanuts are the 12th largest crop in the United States, with a farm value of close to \$1 billion a year, with the Southeast serving as the main peanut-producing region.

Peanuts are important nutritionally, too. Packed with proteins, healthy fats and a broad array of essential vitamins and minerals, they are considered an almost complete food. Their flavor, protein and fat profile make them nearly perfect from a food-processing standpoint, as well. From his lab at Tuskegee University in the early 1900s, the agricultural researcher George Washington Carver discovered approximately 300 food and non-food uses for the versatile legume, including peanut butter. Now, from

his lab in a building on the N.C. A&T campus named for the famed food chemist — Carver Hall — Ahmedna is continuing that legacy.

The challenge

Ahmedna knew he would need to address the allergy issue ever since he began researching alternative, value-added products for peanuts in 2001, with funding from the Collaborative Research Support Programs (CRSP) in the United States Agency for International Development (USAID).

The mission of CRSP is to support university research that improves the economic value of crops that are important in both the United States and a partner nation in the developing world, while at the same time building the agricultural research capacity of that partner. In Ahmedna’s case, the selected crop is peanuts, and the partner is the West African nation of Senegal.

Peanuts are regarded by USAID as one of several ideal crops for economic development. Not only are they nutritious, but they are suited to the hot, arid climates and depleted soils that exist in many developing nations. Instead of requiring added fertilizer, they actually build fertility by fixing nitrogen, which makes them suitable for use in crop rotation.

Throughout the project, Ahmedna has developed several products and processes from the legume, including a low-fat, high-protein meat substitute, a nutritious powdered infant formula well-suited for developing nations, and an inexpensive process to remove aflatoxins, which are toxins that come from a mold that is found in virtually all peanuts to varying degrees. His work garnered him the USAID’s George Washington Carver Agricultural Excellence Award in 2006, in recognition of his “forward-looking research in peanuts and peanut products to improve the quality of life for West Africans.” Early on in the project, he had also

In the days after the news broke about Dr. Mohamed Ahmedna’s process for inactivating peanut allergens, the story was picked up by all the major national TV networks, local TV stations and newspapers across the country, and dozens of international Websites.



started exploring methods for removing allergens.

“Everywhere we went, when we presented our work, inevitably someone would ask, ‘But what about allergies?’” Ahmedna said. “We knew that at some point, we would have to address that issue.”

To illustrate, he pulled out an article from a local paper that reported in 2005 on his early progress in removing about 70 percent of allergens from defatted peanut flour, and pointed to a section in which a peanut-allergic woman was quoted as saying that she looked forward to the day when she could try a spoonful of peanut butter.

“That was my challenge,” Ahmedna said with a smile. “I knew then that I had to continue.”

In fact, by that time, he had already fully intended to see the project through to completion, and was confident that success was a matter of optimizing the process.

Adding value to agriculture

Ahmedna’s success has to do with his career-long focus on extracting value-added products from underutilized agricultural byproducts, including procedures to isolate proteins from grains and legumes. Such isolates are used by the food ingredient industry as emulsifiers or functional ingredients in processed foods, or in powdered diet and protein shakes. One process he worked on while pursuing his Ph.D. at Louisiana State University was a protein isolate from

wheat, which is now used by a food ingredient company.

At N.C. A&T, Ahmedna brought his expertise in this area to bear on peanuts and peanut byproducts. Originally, he focused on value-added products from defatted peanut flour — a protein-rich byproduct that is left after oil is pressed from the kernels. Ahmedna isolated the proteins from the flour appropriate for use as a food ingredient in convenience foods or shakes for fat-conscious Americans, or as a staple for protein-deficient diets in Senegal and other developing nations.

Because of his success in altering peanut proteins, Ahmedna next wanted to find out what effect his methods would have on allergens in peanuts.

“Allergens are proteins too, so we wanted to see if our protein altering processes had any effect on them as well,” he said.

Sure enough, he observed the structure was altered. But more work needed to be done. Was the protein altered enough to make it unrecognizable to the immune system? And would the same process, or one related to it, also work on whole kernels as well as flour?

“We knew that for this to be a viable product, we had to make this work on the whole kernel, so that snack food companies could make use of it,” he said.

“We were able to optimize the process until we were able to achieve a 100 percent reduction in allergens on whole kernels, in a relatively short time.”

Allergies a modern day issue

Most people are attracted to the rich flavor and aroma of peanuts, but this delicious, nutritious food has increasingly been regarded with a healthy degree of caution, because of the dramatic increases in the number of children with peanut allergies in recent years. Schools, airlines and other institutions that serve the public have increasingly limited their use, due to public health and liability concerns. One study showed that between 1997 and 2002, peanut allergies in children doubled in the United States. Today, experts believe that approximately one percent of children in the nation now suffer from an allergy to peanuts, said Dr. Wesley Burks, chief of the pediatric allergy and immunology division at Duke University Medical Center.

“Nobody really knows why,” he said.

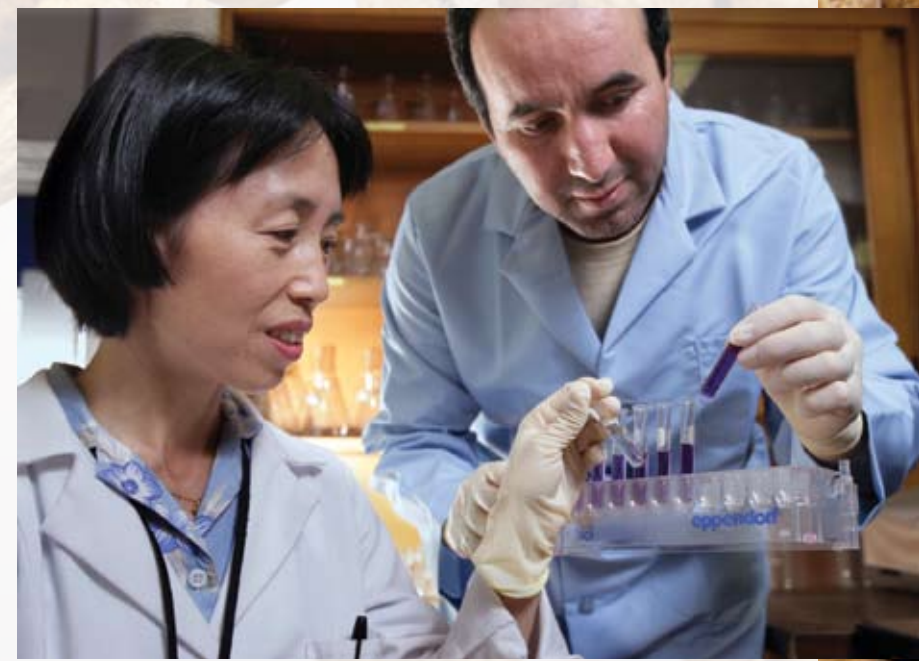
One possibility, the “hygiene hypothesis,” states that children in industrialized nations now live in overly sanitized environments that prevent exposure to the appropriate levels of pathogens that prompt the immune system to develop defenses. The immune system, which develops in the first 12 years of life, evolved over millennia in conjunction with changes in the environment, but nowadays people

don’t live as close to nature as our ancestors did. However, many scientists acknowledge that testing the hypothesis is difficult to impossible, so it remains speculation. Another theory is that exposure to pesticides or other chemical toxins that are prevalent in industrialized nations interfere with the developing immune system, and are

steamed, boiled or stir-fried, which doesn’t seem to affect the proteins the way roasting does. That theory seems plausible to Dr. Jianmei Yu, a research scientist in Ahmedna’s lab, and co-inventor of the process.

“In China, we don’t see all these allergies,” she observed.

Whatever the cause, peanut allergies in the industrialized world



Dr. Jianmei Yu (left), an SAES research scientist, and Djaafar Rehrah, a research associate, have been key contributors to the findings coming out of Dr. Ahmedna’s lab.

responsible for the rise in allergies in general. Still another hypothesis holds that roasting peanuts alters the proteins to make them more allergenic. Cuisine in Asia and elsewhere calls for peanuts to be

appear to be here to stay for the foreseeable future. The process developed through the Agriculture Research Program at N.C. A&T could help reverse that troubling trend.

Re: more information

www.ag.ncat.edu/research/interviews

New technology now gives Dr. Mulumebet Worku and other researchers all of the DNA from the bovine genome arrayed on microscope slides.



Mastitis markers

■ A genomics researcher in the Agricultural Research Program at N.C. A&T is exploring the bovine immune system in hopes of one day contributing to antibiotic-free treatments for mastitis.

This inflammatory disease of the cow's udder remains the dairy industry's most costly foe. It is not unusual for a small farmer with a 50-cow herd to see \$10,000 a year in potential profits gobbled up by veterinary bills, medications, dumped milk and dead cows. In the United States alone, mastitis costs the dairy industry \$2 billion annually, and that figure is multiplied several times over worldwide.

Genomics researchers are now beginning to zero in on the genes and mechanisms of the disease. Among these scientists is Dr. Mulumebet "Millie" Worku, who is focusing on *E.coli* mastitis. The bacterium accounts for approximately one-third of all cases of mastitis, and tends to be the most difficult to treat.

"The problem with *E.coli* mastitis is that it affects the best producing cows, and the problem with antibiotics is that they tend to promote drug-resistant bacteria," Worku said. "We are already running out of treatments for many diseases, so now we need to understand the immune system at the molecular level, so we can develop vaccines, or methods for identifying ani-

mals with natural resistance, and we won't have to rely so much on chemical therapies."

Doing so, however, is a very tall order and a long-term project. It involves understanding how thousands of specialized cells, biological compounds and chemical reactions shift and alter in response to different inputs from the environment — especially microbes. Worku is adding pieces of the puzzle, with the aim of eventually assembling them into a coherent whole that will show the pathways of immunity.

"When a pathogen invades the host, it sets off a cascade of events," she explained.

Some genes up-regulate, which means they switch on or "express" and give the order for other cellular structures to begin producing proteins such as enzymes or other compounds that serve specialized functions in the immune response. Other genes down-regulate, or switch off completely. There could be dozens, hundreds or thousands of genes involved in the specific immune response that Worku studies, each acting in a coordinated, dynamic fashion.

Most of that terrain is uncharted, but Worku is optimistic about the accelerating pace of research on bovine mastitis — not only in her lab, but in laboratories worldwide. That is thanks largely to advancements in biotechnology.

Genomics researcher navigates a molecular maze for keys to a troublesome disease

The bovine genome sequence was just completed in 2006, and she has spent recent years equipping the Department of Animal Sciences with tools that are crucial to understanding how genes function, including microarray and bioinformatics facilities.

"Now, you can purchase the entire cow genome on glass slides. And the tools have improved so much. Procedures that used to take a year to complete, now you can do in a month," Worku said.

The natural immune response to *E.coli* mastitis is the current focus of Worku's research. Her piece of that puzzle is a white blood cell, or neutrophil (also known as the polymorphonuclear cells, or PMN). These are the big guns of the immune system that rush to the scene of infection at the first sign of trouble and kill and "eat" invading microbes. But in the process, they create other problems that Worku is intent on solving.

The destruction of hostile microbes — although essential to fighting disease — also causes inflammation and tissue damage. That's because white blood cells kill invaders by releasing harsh, super-oxidizing chemicals, including chemicals similar to hydrogen peroxide and chlorine bleach. Not surprisingly, these caustic chemicals also damage the body's own tissues. Contrary to popular belief, it is not the invading microbe that causes pain, swelling and redness — it is the body's own immune response to infection. It is for this reason that medical science regards the immune system in cows, humans and all mammals as a "double-edged sword," Worku says. She hopes to find ways to dull one side so it only cuts one way, attacking the invader without causing undue damage to the host. Doing so requires a thorough understanding of the function of the genes involved in inflammation.

In one recent study, she observed that cows that had an overabundance of a specific kind of protein in their PMN cells were also suffering from unacceptably high levels of inflammation. Worku wanted

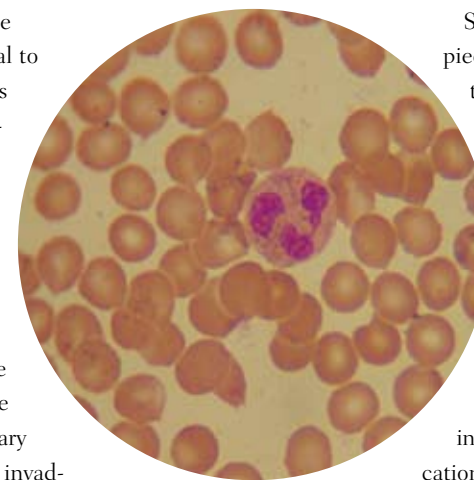
to find out if there was a connection, and discovered that the protein plays a role in preventing programmed cell death — or "apoptosis" of these white blood cells. Cell death might sound like a bad thing, but when it comes to PMN cells, it's a good thing. If they did not quickly die after killing the invading microbe, they would keep pumping out caustic chemicals, and inflammation would continue indefinitely. Worku found that is precisely what happens in some cows. Now she is seeking the gene for the protein.

E.coli has also come under scrutiny in her lab. She knew that milk has natural compounds that counteract the bacteria's toxins, and wanted to find out how they work. In the process, she discovered four genes in *E.coli* that were important in the microbe's response to whey. This information can be used in isolating natural compounds in milk that could be used in therapies.

She has found several other pieces of the puzzle, including two targets in neutrophils for non-antibiotic treatments, and four important gene markers that play a role in fighting *E.coli* mastitis, both in humans and in cows. Once more is understood about the pathways in the total immune response, these markers could become targets for recommending breeding programs or for medications.

Worku is continuing to add pieces to the puzzle. She is beginning to work with an animal model, a 1 millimeter-long worm, *Caenorhabditis elegans* that contains the same genes that are in cows, humans and other mammals. Studying the effects of *E.coli* toxins and natural anti-inflammatory compounds in milk on the DNA of *C.elegans* could provide important clues to treating inflammation in cows, humans and other mammals.

Although inflammatory response to *E.coli* in cows is the focus of her research, Worku says it could have broader implications, because so many of the same genes that modulate bovine immunity are also important in goats, humans and other mammals.





Longer life

Research on a packaging technology could extend shelf life of exotic mushrooms

■ A packaging technology for exotic mushrooms that is being researched by the Agricultural Research Program could be a boon to the small but growing shiitake industry in North Carolina.

Dr. Ipek Goktepe, a food scientist, is researching a technology known as modified atmosphere packaging — a system that uses special equipment to seal fresh food inside plastic pouches or containers with natural gases. She is collaborating on the research with A&T's Dr. Omon Isikhuemhen, whose expertise lies in fungal biotechnology and cultivation.

Mushrooms are highly perishable, even more so than other fresh produce, which is why the technology is needed, Goktepe explained.

"Like all fresh produce, they are still living after they are picked, which means the cells are still respiring," she said. "This packaging technology slows down the respiration, and that way extends the shelf life."

Modified atmosphere packaging is nothing new. Any consumer who shops in a grocery store has come in contact with the technology — if not the term. The sturdy, airtight plastic pouches that hold fruit juices, meats, fresh pastas, frozen pizzas and other foods are forms of atmospheric packaging. What is new is the application of the technology to mushrooms — and to exotic mushrooms in particular.

Other researchers have tried developing atmosphere packaging for mushrooms in the past, but with poor results. Goktepe, however, has so far reported encouraging results. Some exotic fungi begin spoiling five to seven days after picking because of their rapid rate of respiration. By tweaking the gas mixtures, Goktepe was able to slow down the breathing and extend the shelf life from seven to 21 days for shiitake; from seven to 18 days for portabellas; and from seven to 14 days for an exotic variety known as

"pom-pom" mushrooms. The method she came up with has a patent pending.

Some consumers might be uneasy with the idea of adding gases to foods, but in reality the gases that we breathe in normal air are the very same ones used in modified atmosphere packaging, only in different proportions. Typical air comprises 78 percent nitrogen, 21 percent oxygen and .01 percent carbon dioxide. Goktepe's research is aimed at finding a different, optimal mix of these gases to slow respiration and retard spoilage, without causing any off-odors or discoloration.

One of the purposes of the project is to give options for the small, but growing shiitake industry in North Carolina. Donald Lunsford, president of the North Carolina Mushroom Growers Association, thinks the technology could be a good thing for shiitake growers.

"The problem with shiitake is they don't travel well," he said. "Obviously anything that can be done to extend shelf life and extend it in a way in which the product looks fresh and appealing is an advantage," he said.

Lunsford is among the more than 240 growers who got started growing shiitake in North Carolina as a result of the mushroom program that was started by Agricultural Research and The Cooperative Extension Program at N.C. A&T in 2002. He says he picks and sells about 30 pounds a week for nine months out of the year from his outdoor log production site, and is now preparing to start growing indoors for higher yield production. The \$3,000 price tag for a small modified atmosphere packaging system is affordable for small growers, Lunsford added.

Other food industries are also interested. The University's Office of Outreach and Technology Transfer reports that a major North American produce processor has taken an interest in the research, and has asked for more tests, which Goktepe is now conducting.

Whoever winds up using the technology, the end result should be a process to ensure mushrooms stay fresh longer on grocery store shelves, or at home in the refrigerator, which in turn could mean lower prices and a higher quality product.

Dr. Ipek Goktepe is working on a new process for packaging mushrooms that simplifies shipping and extends shelf life.

Ag. research produces University's first spin-off company

Provagen will produce an antibody-binding protein for use in medical research, diagnostics and treatment

■ The discovery of a rare antibody-binding protein in the Agricultural Research Program laboratories has given rise to N.C. A&T's first spin-off company.

The company, named Provagen, is a biotech firm that will produce and market the patented "Protein V" for use in medical research, diagnostics and treatment. Protein V is believed to be one of the most versatile and strong antibody-binders known, and thus could improve research and industrial processes that rely on purified antibodies.

One possible application for the protein is in the growing field of medicine known as immunotherapy, which treats disease by stimulating the patient's immune system. Protein V is potentially profitable because it can extract more antibodies from blood serum and tissue cultures than similar products on the market. It forms strong chemical bonds with all types of immunoglobulin G (IgG), which is the most prevalent group of antibodies in humans and other mammals. The protein was discovered and subsequently developed into a viable product by Dr. John Allen, a molecular biologist in the Department of Animal Sciences.

"We are delighted when our research makes it into the hands of those who can benefit from it, in this case the medical industry and the

public," said Dr. Alton Thompson, dean of the School of Agriculture and Environmental Sciences. "Translating research into products and processes to improve the well-being of society, the economy and the environment is the essence of the land-grant mission."

As with any biotech startup, it will take several years before Provagen makes its first shipment of Protein V. While Allen is continuing research on product development, the University's Office of Outreach and Technology Transfer is steering the business side of the venture, with assistance from the North Carolina Biotechnology Center. A CEO has been hired, and the company is now seeking funding and considering sites, including the new north campus of the Gateway University Research Park in Greensboro and the North Carolina Research Campus in Kannapolis.

Seeking a quicker diagnostic test

Most discoveries happen when you are looking for something else, and Protein V was no exception. Allen had started out in his research with one objective in mind, only to veer into another, more productive avenue when it became apparent he was on to something important.

It began when he first arrived at A&T in 1985, bringing with him from his prior employment in a medical

Provagen Inc.
*Dr. John Allen, President
 & Chief Scientific Officer*

diagnostics firm an extensive knowledge of a bacterium known as *Gardnerella vaginalis* — an organism that causes a sexually transmitted disease that doctors usually describe simply as “bacterial vaginosis.” (The “V” in Protein V stands for vaginalis.) Allen saw the need for a quick method to diagnose the disease, because at that time, the standard diagnostic tools took from one to two days for results, which also meant a delay in treatment.

With funding from the National Institutes of Health, he set out to develop a rapid test — an objective that would require a thorough understanding of both the bacterium, and the specific antibodies in IgG that bind to it.

Many diagnostic tests work with the use of purified antibodies that scientists such as Allen have spent years of basic research in identifying. Once discovered and purified, these antibodies can then be included in assay kits that clinical staff anywhere can use to test for disease. Technicians run such tests by exposing a sample of body fluid from the patient to the specific antibodies, and then add other compounds that will change color — but only if the antibodies have attached to the pathogen in the sample. Within 15 minutes or so, a simple visual inspection tells the story: A blue spot means positive because the antibodies have attached; clear means negative.

It was this type of test for *G. vaginalis* that Allen was trying to develop. Instead, he stumbled onto something that promised much broader applications in medical research, treatment and diagnostics for many more diseases.

An unusual discovery

Finding specific antibodies to match up with each disease is no small task. Usually there is only one specific antibody that pairs up with one strain of any given pathogen, and there are hundreds of thousands of different antibodies freely circulating in blood. Meanwhile, there are typically thousands of different strains of any one pathogen in nature, which further complicates the task.

In order to identify the specific antibodies in IgG that could be used in diagnosis, Allen had to collect samples from pathogen banks all over the world that housed samples from Europe, Africa, North America and Asia. He ran thousands of tests, screening more than 5,000 specimens of *G. vaginalis*.

But while he was gathering important information about antibodies, he also discovered something odd about some of the bacteria. A few strains seemed to have a protein that interacted in an unusual way with IgG. Instead of just one specific antibody bonding to the bacteria, virtually all of them were latching on to a handful of samples. Antibodies aren't supposed to behave that way, and this sparked Allen's curiosity.

He knew he was observing something unusual, because he knew how antibodies work: These Y-shaped chemical compounds grab hold of hostile bacteria by latching on to proteins on their cell wall, using the top two ends of the Y, or “fAB” side. The “handle” of the “Y” — known as the “fC” side — is left dangling to attract white blood cells, which chemically bond with it, and then kill the invader. At least that's the way it's supposed to happen. Allen theorized that if virtually all antibodies were attaching to the bacteria instead of only specific ones, that action could mean they were forming bonds upside down, on their fC sides.

A rare occurrence

At first he thought what any scientist would: Something had gone wrong in the lab. But hundreds of tests later there could be little doubt. These few bacterial strains had proteins that were, in fact, bonding to all IgG antibodies on the fC side. And Allen knew that meant that these strains had very unusual proteins. Such bacteria are extremely rare in nature — which happens to be very fortunate, because white blood cells don't recognize them as a hostile enemy, which leaves them free to multiply at will. Such so-called “super-bugs” might also be antibiotic resistant, putting the victim in deep trouble.

However, Allen knew that the protein in the bacterium, which he named “Protein V,” was also potentially very valuable to medical science, and could have broader applications than the single diagnostic test he was originally pursuing. Only two other proteins with similar properties have ever been identified (known as Protein A and Protein G), and they had already been developed for use in extracting monoclonal antibodies from blood serum and tissue culture. Monoclonal antibodies are those that have been identified as specific to a disease, isolated and then “grown” inside



Dr. John Allen, an SAES microbiologist/molecular biologist who will be president and chief scientific officer of A&T's first spin-off company, at work in the lab with Andrea Byers, a research assistant.

rodents or tissue culture. They are then extracted for use in medicines and research with the use of Protein A or G.

Protein V will do the same thing, but it can fill a need because it has several advantages over the other two. Not only is it very heat stable, it also binds to a wider array of antibodies from humans, cows, horses, goats, mice and other mammals. That means it can extract a broader range of monoclonal antibodies, and hold up well in lab experiments.

“We showed this to biochemists all over the world in university, government and private industry labs, and the response was always the same, ‘This is incredible. You have to pursue this.’” Allen said.

He took the advice, and has since identified the gene for Protein V, sequenced it and cloned it into non-pathogenic bacteria so they can be used safely in production. The University has patented the protein,

and has six other patents pending on industrial processes that use it.

The first spin-off

Provagen has also laid a foundation for future technology transfer from the Agricultural Research Program. An important catalyst in the process was the North Carolina Biotechnology Center, which supplied a \$50,000 seed loan and helped recruit a chief executive officer with experience in biotechnology startups.

“North Carolina is very fortunate to have an institution to serve in this capacity, to help assure that promising university research makes it out of the laboratory and into the marketplace where it can deliver practical benefits,” said Doug Speight, assistant vice-chancellor for outreach and technology transfer.

Establishing spin-off companies from university research requires three critical elements, he said. First, of course, is commercially viable

science. Second is start-up capital, and the third, most critical element is management.

“Typically, universities have the science, but lack one of the other two elements,” Speight said. “Thanks to a supportive environment for biotechnology in North Carolina, we have all three.”

It took approximately eight months to establish Provagen, but it will take several years of product development before the company begins taking orders. Startup biotech firms usually take several years to begin production.

Allen, who is serving as president and chief scientific officer for the company, remains optimistic.

“Everywhere we tested it, we found it superior to everything on the market now,” Allen said. “What does that mean for consumers? Ultimately anything that can improve industrial processes has the potential to mean better and cheaper products.”

Childhood eating habits

Study to examine eating habits of young children and families



Camren Hayes, 5, asks for more.

Overweight is now considered America's number one killer, outpacing even smoking as the top public health issue facing the United States. But overweight and obesity are no longer the afflictions of the middle-aged couch potato. Overweight increasingly affects young children at alarming rates and with troubling consequences for their developmental years.

This trend has led Dr. Valerie Jarvis McMillan, an early childhood researcher, to embark on a new study of eating habits of preschool children. The urgency of the topic is underscored by a raft of sobering statistics: In North Carolina, more than 10 percent of preschool children between the ages of 2 and 5 are

overweight or obese, and the rates are continuing to climb. The Child Advocacy Institute reported a 26 percent increase in overweight children aged 2 to 4 in the United States, between 1995 and 2000.

Overweight in children has long-term ramifications for physical and psycho-social development, McMillan says.

"As the prevalence of childhood obesity continues to increase, we can expect to see an increase in long-term disease in children," she says. "Without intervention, this problem will continue into adulthood, with severe consequences for the future of our youth."

The problem affects them on other levels as well. Studies are showing that, in addition to suffering from diminished self esteem and an impaired ability to move easily, overweight children are developing cardiovascular disease, diabetes and other weight-related illnesses.

Not surprisingly, research shows that parents play an important role in establishing eating habits, and that these habits tend to continue into adulthood. However, very little is known about what specific influences establish eating habits in very young children, and even less is known about what specific factors affect eating habits in minority populations. In order to start filling this knowledge gap, McMillan and co-investigator Patricia Lynch, one of the registered dietitians on the SAES faculty, have embarked on a study, "Factors Influencing Food Preferences, Selections and Eating Practices of African-American Parents and their Children." The two researchers will examine factors such as time constraints, food costs and availability, the influences of peers and social marketing, and other variables.

"Parents and guardians realize that they play an important role in their children's food preferences, and they have a desire to influence them in a positive direction, but in the hubbub of everyday life, what you know is right can take a back seat to what is convenient. That's



Jaiden Burgess, 4, takes a bite.

just one of the many variables we want to understand better," McMillan said.

Participants in the study will be recruited from African American parents and children between the ages of 2 ½ and 5 who are enrolled in the Child Development Laboratory at N.C. A&T. Data on their eating habits and food preferences will be collected over a three-year period, through surveys, videotaped interviews and direct observations of their eating habits in the laboratory, in the home and while dining out.

McMillan cites research that shows just how complex the issue is. For instance, one study looked at age and eating habits, finding that 3-year-olds tended to stop eating when they were full, regardless of the size of the portion on their plates, while 5-year-olds who were given large portions tended to eat more. Other research looked at peer influence, observing that children altered their food selections, depending on what other children seated near them at mealtime

ate. Other researchers are beginning to report the powerful influence that media and advertising have on what youngsters eat. One study in 2003 revealed that the food industry spends an estimated \$13 billion per year in advertising to children, while another concluded that advertising leads children ages 12 and younger to consume high-calorie, low-nutrient food.



Dr. Valerie McMillan



Patricia Lynch

McMillan points out that some industries that market to children are doing a better job of providing low-fat options, and so one of the questions she wants to explore is whether or not families opt for the healthier selection.

"We want to find out if parents select the healthy foods that are available," McMillan said. "Based on some of the trends that we are observing, we think they are less likely to be selected for a variety of reasons, but we won't know until we study this further."

In the end, McMillan and Lynch anticipate the study will contribute to improved intervention strategies, as well as models for improving future studies of children's eating habits.

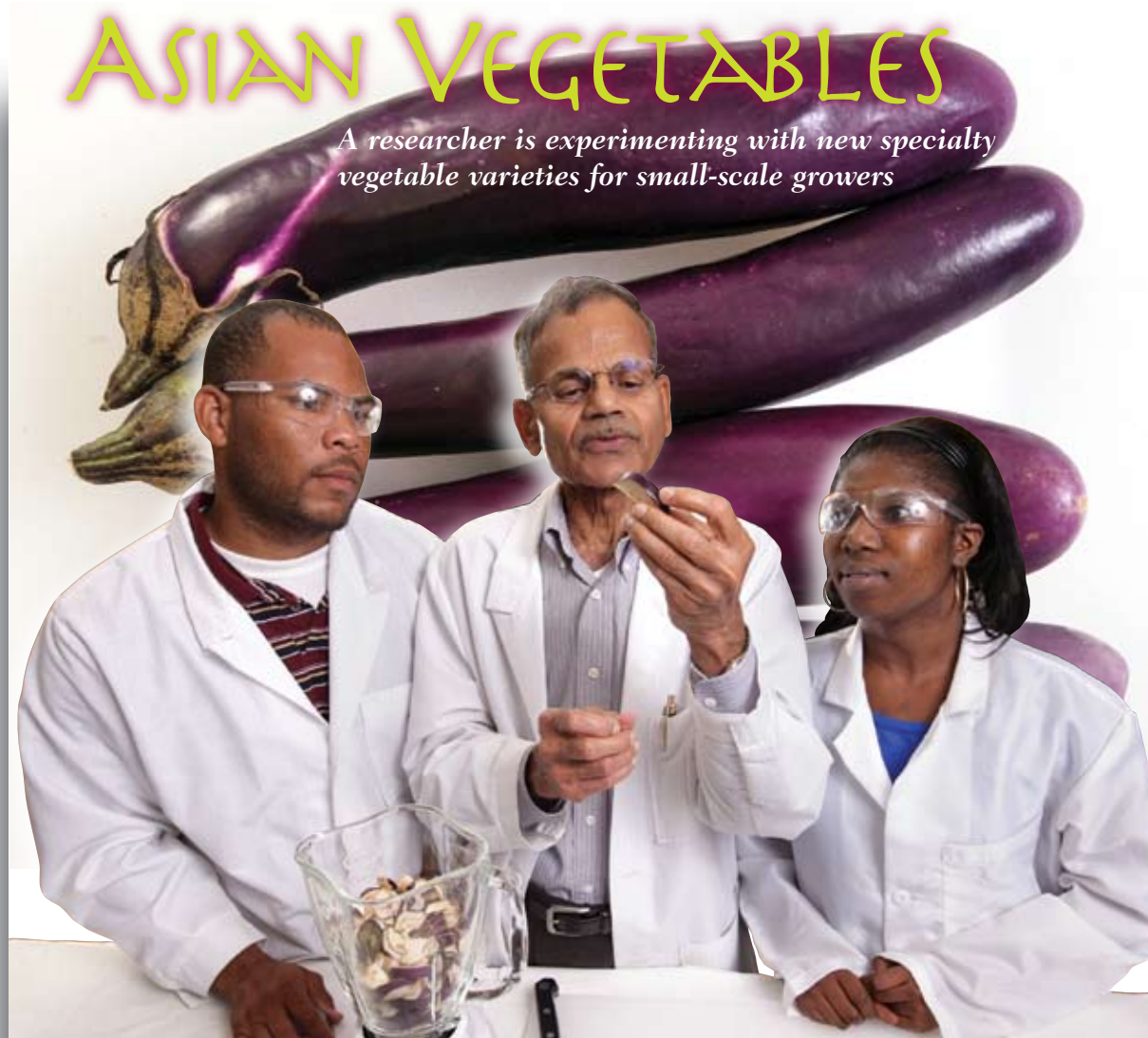
"Families need intervention programs in the form of ongoing coaching and consultation," McMillan said.

Helping others toward positive behavior change is a challenge, but one that parents and guardians eagerly embrace, given enough support provided by such programs, added Lynch.

"You don't want to make people feel guilty," she said. "But, the fact is that we simply don't talk to our children enough about nutrition. We all have to take responsibility for changing that next generation."

ASIAN VEGETABLES

A researcher is experimenting with new specialty vegetable varieties for small-scale growers



Dr. M.R. Reddy gets assistance from graduate students Kurt Taylor and Natasha Oris-Thomas in exchange for the guidance he gives them in phytonutrient analysis of Asian eggplant varieties (in background).

two varieties of specialty melons, Sprite and Sun Jewel.

Now he is turning his attention to Asian vegetables, which he thinks could be another option for farmers, although he cautioned that growers wishing to sell to Asian markets should diversify, and not concentrate on just one crop.

“The market is not large enough for huge quantities of these vegetables. Instead of growing five acres of one vegetable, it would make more sense for a grower to grow one acre each of five different vegetables,” he said.

The four vegetables he will experiment with are popular among Asian consumers, and include Asian greens, long squash, an edible gourd known as luffa, and a variety of eggplant.

Asian grocery stores are increasing in metropolitan areas in the state, and Reddy believes small farmers could sell to these independently owned “mom and pop” stores. At present, they purchase most of their fresh produce from Florida. Reddy and The Cooperative Extension Program at N.C. A&T have identified more than 50 privately owned Asian grocery stores in the state and conducted some informal interviews with a few store owners, who indicated they would be willing to buy from local sources.

But before encouraging farmers to plant, some of the questions that Reddy wants to answer include how well do these vegetables perform under North Carolina conditions, and how can farmers realize the most profits? He plans to find out by comparing the growth and yield of the vegetables under four different application rates of nitrogen, phosphorus and potassium (NPK). He also will grow the crops in fields that have been planted with a winter cover crop

of rye and crimson clover, which will be plowed under prior to planting with the vegetable crops.

Reddy said that previous research has shown that this cover crop provides a good carbon/nitrogen ratio for North Carolina. The rye provides biomass to build organic matter, while the nitrogen-fixing ability of crimson clover reduces the crop’s chemical nitrogen needs by half. To see how well this cover crop performs with the Asian vegetables in question, he will monitor the decomposition rate and measure the uptake of NPK by the vegetables.

Finally, he will identify and measure the phytochemical compounds in the harvested vegetables, and compare the content to similar varieties of conventionally grown vegetables. This objective is important in light of increasing interest from consumers and industry toward these health-promoting compounds.

“Consumers are increasingly interested in the nutritional content of foods. If these vegetables have a favorable profile, it could provide an additional edge in marketing them,” Reddy said.

Chinese okra is an edible variety of luffa gourd often used in rice dishes, soups and stews.



■ With tobacco in decline due to global competition and the end of the tobacco subsidy program, limited-resource farmers in North Carolina and throughout the Southeast are trying alternative crops, including specialty vegetables.

To help accommodate this new interest, Dr. M. R. Reddy is researching the performance of four different Asian vegetables that will be grown using sustainable agricultural techniques, including winter cover crops and nutrient management. In a new direction for research, he is also planning to evaluate the phytonutrient content of the vegetables.

Phytonutrients are one of the newest frontiers in human nutrition research, and they are frequently used in nutraceutical supplements, behind labels touting their life-enhancing properties. Primarily found in fruits, nuts and vegetables, these natural chemicals include such sub-

stances as antioxidants, beta-carotenes, protease inhibitors and omega fatty acids, to name just a few. Although they aren’t essential to basic life processes the way vitamins are, phytonutrients do play an important role in bolstering immunity, easing inflammation, enhancing brain function and fighting cancer, among other things. The National Nutraceutical Center at Clemson University reports that the nutraceutical industry is worth \$86 billion a year, and is rapidly growing by 7 percent to 12 percent annually, with more than 40 percent of Americans using them to enhance health.

Reddy is best known for his work with melons. In the past, his experiments and demonstrations helped establish seedless watermelons as a viable crop in North Carolina. More recently, he has demonstrated how North Carolina growers could net \$2,000 to \$4,000 an acre growing

Tracking truffles

■ Research into the DNA of a high-value soil fungus in N.C. A&T's Agricultural Research Program has spurred the creation of a new biotech business to serve and support truffle growers.

Mycorrhiza Biotech of Burlington, N.C. is getting started in the soil fungus detection business, with the aid of the DNA barcode for truffles (*Tuber melanosporum*), which was developed by Dr. Omon Isikhuemhen, an A&T researcher, and his collaborators at Duke University. Isikhuemhen is continuing to serve as a consultant to the business, contributing his expertise in fungal biotechnology and cultivation.

The company's name derives from the group of agriculturally and ecologically important soil fungi that the truffle organism belongs to, known as *mycorrhiza* (pronounced my koh rye' za).

"I'm a truffle grower myself, so I know how important detection is," says owner Nancy Rosborough.

Truffles are a delicacy used in European cuisine, and considered the most expensive agricultural crop in the world. The black, golf-ball-sized tubers

can fetch \$500 or more per pound on the wholesale market.

Attracted by the potential profitability, dozens of growers across the state, and many more around the world, are trying their hands at cultivating truffles. However, it could take up to a decade before a grower will dig up his or her first crop, because it takes years for the slow-growing organism to mature in undisturbed soil on the roots of its favorite host trees — usually hazelnut

or oak. The venture is made all the more risky by the fact that truffles are very fussy about soil conditions, and are easily out-competed by other soil fungi, especially closely related species. Indeed, it is only in recent years that it was believed possible to cultivate truffles. Traditionally, the tubers had only been available through wild harvesting in Europe's woodlands, often with the aid of trained truffle-sniffing pigs or dogs. However, in recent years a technique for inoculating seedling roots of host trees with the mycorrhiza was developed, and some growers have reported varying degrees of success at cultivating the fungus.

That's where Mycorrhiza Biotech comes in. The firm

DNA barcode helps minimize risk of truffle farming



Dr. Omon Isikhuemhen

provides monitoring and detection services for growers by checking seedling root samples for the presence of truffle DNA. Prior to Isikhuemhen's research, such monitoring was virtually impossible.

The new monitoring service should mitigate the risk in truffle farming by alerting growers whether or not the fungus is still surviving in the root zone of their trees. Mycorrhiza Biotech is certifying host seedlings for inoculation companies, monitoring samples taken from growing trees and testing soil for competing fungi.

Truffle monitoring is just the beginning for the company, which

plans to provide similar services to detect many other mycorrhizal fungi that are used in sustainable agriculture. These specialized organisms need sugar to survive, but lack the ability to undergo photosynthesis. Instead, they grow on roots of specific host plants that provide the sugars that they cannot produce on their own. The fungus returns the favor by scavenging nutrients through a network of tiny filaments that can reach a much wider area than the host's natural root zone. That characteristic makes them

highly valued as biofertilizers.

For now, Mycorrhiza Biotech is getting its feet wet with truffle monitoring and certification, but Rosborough said the company is planning to help advance the potential of the soil organism through other detection and soil monitoring services that can serve other agriculture, forestry and turf grass industries.

Nancy Rosborough is a biotechnology entrepreneur who has been receiving scientific guidance from A&T's Agricultural Research Program.





Agricultural Research Program at N.C. A&T State University

More than 35 projects in the Agricultural Research Program are under way or were recently completed. Following are brief descriptions of some, organized by the six program initiatives of the School of Agriculture and Environmental Sciences:

I. Agromedicine, Nutrition and Food Safety — Promoting health, nutrition and safety in communities that depend on industries based on agriculture and natural resources

Campylobacter jejuni Studies with Non-Antibiotic Additives in Poultry Production

Principal investigator: Dr. Willie L. Willis
The data from this study indicate potential efficacy of pokeweed extracts against the leading causes of food-borne illness, *Campylobacter jejuni* and Salmonella, and suggest that additional research is warranted to determine if similar results occur in floor pens or commercial field studies. This could eventually lead to major reductions in infected broiler chickens entering the processing plant.

Enhancement of Microbiological Quality of Probiotic Supplements in North Carolina

Principal investigator: Dr. Salam Ibrahim
New processes to maintain high viability of probiotic cultures throughout processing and storage are needed to ensure that consumers get the benefits of these healthy bacteria. Researchers addressed this need by developing a new growing medium for use in quality control that is more effective than mediums currently in use.

Evaluation of Select Plant Extracts as Potential Food Preservatives and Anticarcinogens

Principal investigator: Dr. Ipek Goktepe
Progress thus far suggests that compounds in rosehips may be helpful in cancer prevention and treatment. Crude extracts of rosehips in the test tube significantly reduced the growth and proliferation of colon, breast and cervical cancer cells. Work is continuing on other plant extracts, including pokeweed, bitter kola nut and Pleurotus mushroom.

Functional Food Ingredients from Select North Carolina Agricultural Byproducts

Principal investigator: Dr. Mohamed Ahmedna
Research thus far has shown that peanut skins have potent antioxidants with potential as an inexpensive functional ingredient in food or supplements, and as a food preservative. The project also demonstrated that a high-protein, low-fat meat substitute can be developed from defatted peanut flour. These novel uses of peanut industry byproducts could add value to the peanut industry in developing nations as well as in the United States.

Improving Grifola Frondosa for High Yields and Medicinal Values

Principal investigator: Dr. Omon Isikhuemhen
Researchers are continuing to gain a better understanding of the biology of *Grifola frondosa*, an edible and medicinal exotic mushroom that is increasingly

in demand for use in culinary and nutraceutical preparations. Most of the mushrooms used in nutraceutical preparations in the United States at present are imported from Japan and China. Identifying appropriate commercial strains and simple reproducible production methods are critical to increasing local production of this mushroom.

A Nutrition, Physical Activity and Behavioral Intervention Program to Improve Healthy Eating and Physical Activity Among Hispanic Women

Principal investigator: Dr. Lizette Sanchez-Lugo
Nationally, the prevalence of age-adjusted combined overweight and obesity is 71.9 percent in Hispanic women. To address this issue, a pilot, 12-week intervention to improve healthy eating and exercise behaviors among Mexican-American women has been completed. Results from the study will be used to develop culturally relevant health programs for Hispanic women.

II. Biotechnology and Biodiversity — Plant and animal systems research, including genetics, with beneficial implications for human well-being

Biological Conversion of Crop Residues to Fuels and Chemicals

Principal investigator: Dr. Ghasem Shahbazi
The objective of this work is to develop technologies to convert corn stalks and cheese whey into biofuels and biomaterials, including hydrogen, bioethanol and succinic acid — a chemical used by the pharmaceutical industry. The production of fuels and other materials could create new or value-added crops for farmers and foresters, and provide jobs for rural communities. The use of 10 percent ethanol blends from renewable resources could also improve air quality and reduce global warming by reducing greenhouse gases.

Characterization of Enterotoxigenic Escherichia Coli

Principal investigator: Dr. John W. Allen
The economic impact of scours on the swine industry is profound, contributing to annual losses of \$35 million. This project is seeking a basic understanding of the mechanism of this costly disease, and is in the process of characterizing strains of the pathogen — Enterotoxigenic (toxin producing) *Escherichia coli* (ETEC) — so that therapies can be developed.

Deciphering Gene Expression Associated with the Inflammatory Response to E.Coli Endotoxin in Cattle

Principal investigator: Dr. Mulumebet Worku
The results of these studies contribute to the under-

standing of *E.coli* mastitis, the most common cause of fatal mastitis in cattle, which occurs in lactating cows within the first weeks after calving. Understanding *E.coli* pathogenesis and immuno-modulation of *E.coli* genes may contribute to strategies for using the cows' immune response and genetic makeup to combat bacterial infection. The results of these studies have thus far shed more light on the immune factors in milk that contribute to the anti-inflammatory response.

Development of a Hands-On Laboratory Experiment for Characterization of Biodegradation of Agriculturally Derived Polymers/Plastics

Principal investigator: Dr. Jianzhong Lou
A new approach to characterizing biodegradable polymers has been developed, and should improve understanding and techniques for characterizing and controlling the properties of biodegradable polymers. The characterizing techniques can be applied to further research and/or manufacture of biodegradable polymers.

Micropropagation Protocol Development to Enhance Production of Economically Important Plant Species

Principal investigator: Dr. Guochen Yang
Researchers have developed a biotech protocol for growing an ornamental evergreen shrub that is in high demand, but in scarce supply due to the difficulty of conventional propagation. A patent disclosure has been filed. The findings and/or protocols from this project could also be applied to other plants that are difficult to propagate.

Production and Characterization of Low-Cost Biodegradable Polylactic Acid Using Cheese Whey

Principal investigator: Dr. Ghasem Shahbazi
With the use of ultrafiltration, nanofiltration, reverse osmosis and polycondensation, researchers developed a system for producing biodegradable plastics from cheese whey, and are now characterizing the product. The use of biodegradable plastics could significantly reduce pollution and landfill costs associated with plastic packaging materials, and provide a value-added product to cheese producers.

Strengthening the Interdisciplinary Biotechnology and Biodiversity Program

Principal investigator: Dr. Guochen Yang
Biotechnology is the fastest growing industry in the United States and North Carolina has the third largest biotechnology industry in the country. However, there is a shortage of high-quality biotechnology professionals, especially minorities. This project contributes to strengthening faculty, staff and student knowledge, and improves the capacity of North Carolina A&T State University to train and educate agricultural scientists in biotechnology.

III. Human and Community Development — Socioeconomic, infrastructure, and public

policy analysis for fully optimizing human capital and strengthening communities

Assessment of Community-Based Organizations in Black Belt States

Principal investigator: Dr. Terrence Thomas
The project will produce digital maps and a database describing the location and characteristics of community-based organizations in the Black Belt, to enable researchers, Cooperative Extension personnel, rural development agencies and policy makers to identify potential partners more accurately and efficiently.

An Economic Assessment of Farmland Loss in North Carolina

Principal investigators: Dr. Donald McDowell and Dr. Anthony Yeboah
Total acreage of land in agriculture declined in North Carolina by an average of 232,000 acres per year between 2002 and 2006, while the average farm size increased. Results have led to the enhancement of existing agricultural policy courses, and additional graduate and undergraduate courses in agricultural economics.

Factors Influencing Leadership Development and Community Involvement in Limited-Resource Communities

Principal investigator: Dr. Jane Walker
In recent years, manufacturing layoffs accounted for 87 percent of job losses in rural counties in North Carolina. Because of the strong likelihood that the decline will continue, rural communities must take steps to attract or develop viable employment alternatives. Defining the factors that impact leadership development could lead to new or improved programs to develop future leaders, and contribute to the sustainability of rural communities.

Hard to Reach Consumer Food Safety Research and Outreach in the Southeast

Principal investigator: Dr. Kofi Adu-Nyako
Research has discovered gaps in food safety knowledge and practices among different population subgroups, and will be used to inform focused and targeted intervention for maximum effect. The project team disseminated food-safety education materials to new and unique target audiences, including food bank patrons, migrant farmer communities, and predominantly Hispanic, African and other immigrant communities.

Housing Challenges of New Manufactured Home Owners in Rural North Carolina

Principal investigator: Dr. Thess Hinnant-Bernard
More than one million North Carolinians live in manufactured homes, and \$3.85 billion was contributed to the state's economy in 1998 by the manufactured housing industry. The findings of this study will be used to provide education to manufactured home owners, and to create a database for housing researchers, from which they will be able to offer suggestions to the industry.

Impact of Agricultural Industrialization on North Carolina's Black Belt

Principal investigator: **Dr. Godfrey Ejimakor**

The completed study suggests that industrial agriculture and hog production have done little to improve economic well-being in the Black Belt, and that this region will need to invest resources and effort in attracting other businesses, and assess whether some types of industrialized agriculture, such as hog production, have a negative effect on the willingness of other businesses to locate in their communities. The potential impact of the study is information to help guide rural economic development policy.

Promoting Collaboration Among CBOs, 1890 Institutions, Business and Government Agencies, in the Black Belt

Principal investigator: **Dr. Terrence Thomas**

This project will develop a database of community-based organizations (CBOs) by location, program priorities, capacity and method of operation. Policy-makers, businesses and development agencies throughout the region will have access to this information, as will Cooperative Extension, which will be able to use this information to engage CBOs as collaborators.

Rural Entrepreneurship Development in Southeastern North Carolina

Principal investigator: **Dr. Kenrett Jefferson-Moore**

This project will clearly define opportunities for rural entrepreneurs and connect with small-scale agricultural enterprises, existing rural businesses and prospective entrepreneurs in southeastern North Carolina. Researchers expect the project to contribute to rural business growth, rural job creation, economic innovation, community organization and international trade and development.

Understanding the Underlying Factors that Determine Health Status in the Black Belt

Principal investigator: **Dr. Benjamin Gray**

Information gathered from this study will give policy-makers information to create more effective policies based on specific underlying factors that determine health status, including employment status, education, environment, sex, race, income access and proximity to health care resources. To date, the study suggests that not enough is being done to help improve the livelihoods of people who call the Black Belt their home. At completion, a depository of primary, science-based data will be accessible to land-grant universities, governmental agencies, health care advocates and businesses.

IV. International Trade and Development — Helping disadvantaged rural communities fuel economic growth by becoming players in the global marketplace

Economic Assessment of Changes in Trade Arrangements, Bioterrorism Threats and Renewable Fuels Requirements on the U.S. Grain and Oilseed Sector

Principal investigator: **Dr. Osei Yeboah**

The project to date has described the cost of surveillance for BSE (mad cow disease) at \$40 million, compared to the cost of an actual outbreak (\$3 billion). The worst effect would occur in the cattle farming industry, with a loss over \$100 million, but other sectors would bear the costs as well. Given this potential loss, the study indicates that farmers are better off by bearing the surveillance costs. Economic assessments regarding trade and renewable fuels are under way.

V. Small Scale Agriculture — Alternative enterprises, niche markets, innovative farm-based businesses and environmentally sustainable production systems

Determinates of Successful Small-Farm Operations in North Carolina

Principal investigator: **Dr. Anthony Yeboah**

The goal of the project is to identify factors influencing successful small-farm operations in North Carolina. To achieve these ends, it is necessary to identify the characteristics of successful small farms and determine how those characteristics or factors relate to a small farm's success. Thus far, the project has identified a conceptual model that will be tested and refined through case studies to provide a protocol that can be used to evaluate a small farm operation's success and potential for being successful.

Harnessing Cover Crops to Meet Nutrient Needs in Organic Cropping Systems

Principal investigator: **Dr. Keith Baldwin**

Researchers have observed that organic cropping provides only a small decrease in yield, compared to conventional cropping, and that weeds were managed reasonably well in organic treatment plots. This may make possible an organic production system for organic animal feed stocks at the University Farm, which could serve as a demonstration model for organic farms in the state.

A Strategic Alliance Between Farmers and University to Increase Farm Incomes

Principal investigator: **Dr. Chung W. Seo**

At present, there is no conventional washing method to ensure microbial safety for green, leafy vegetables. A simple and effective washing method for produce that can be adapted by small-scale farmers is urgently needed. This study has shown that a combination of ozone and chlorine dioxide treatment could be an effective and simple method for washing spinach and turnip greens.

VI. Water and Soil Quality — Providing solutions to environmental issues that are practical for small-scale farms and communities with limited resources

Agroforestry and Sustainable Vegetable Production in Southeast Asian Watersheds

Principal investigator: **Dr. Manuel Reyes**

The project is developing sustainable agroforestry-based vegetable production systems for steeply

Teodoro Barrios, manager of the University Farm's Swine Unit, has been guiding SAES students and assisting research scientists so skillfully that he garnered both campus and statewide recognitions for his work. He won the SAES's award to an outstanding non-teaching staff member for the 2006-07 academic year. He was also a recipient of the 2007 State Employees' Award for Excellence, the highest honor that can be bestowed on a North Carolina governmental employee.



sloping hillsides in Southeast Asia, both to alleviate poverty and food scarcity and to reduce environmental degradation. Economically viable, ecologically sound integrated vegetable-agroforestry systems are being developed by and for women and men involved in small-scale agriculture.

Development of an Integrated Constructed Wetland System to Treat Swine Wastewater

Principal investigator: **Dr. G.B. Reddy**

Separating solids and removing phosphorus from swine wastewater remains a challenge. The goal of this project is to describe an integrated technology based around constructed wetlands that will be appropriate for small- to medium-size swine operations to overcome these and other challenges in treating swine wastewater. The project will also explore a low-tech approach to creating fertilizer from filtered wastewater.

Development of Low-cost Water Filtration Systems Using Nutshell-based Activated Carbons

Principal investigator: **Dr. Mohamed Ahmedna**

The development of water filters from activated carbons derived from pecan shells could benefit rural residents receiving drinking water from contaminated wells or other sources, while adding value to the pecan industry. Researchers are finding that activated carbon from pecan shells provides advantages over conventional activated carbon derived from coal. The pecan-derived carbon is more effective at filtering toxins, costs less and comes from a renewable resource.

Granulated Activated Carbon Made from North Carolina Agricultural Byproducts

Principal investigator: **Dr. Chung W. Seo**

Pollution of both ground and surface water is a major environmental problem. This study showed that oat hulls, which are a low-cost, high-volume renewable agricultural by-product, can be converted to adsorbents of metal ions for use in treating wastewater. Conversion of oat hulls into activated carbons to treat wastewater will increase their value and can contribute to safer drinking water.

Identification and Reduction of Nutrient Load at the Upper Haw River Watershed

Principal investigator: **Dr. Manuel Reyes**

The Upper Haw River is an important North Carolina waterway that forms part of the Cape Fear River Basin. Water from the river drains to Jordan Lake, a key water supply for Cary and Raleigh residents, and eventually reaches the town of Wilmington, a popular tourist beach spot in North Carolina. This project will determine the applicability of the Soil and Water Assessment Tool (SWAT) to modeling the Haw. If it is determined that SWAT can accurately describe the hydrology of the river, it could be used for making predictions about the effects of land-use changes on water quality in this region.

Improving Soil Quality Through Soil and Residue Management

Principal investigator: **Dr. Charles Raczkowski**

These experiments will enable an assessment of how soil management practices affect soil quality over the short and long term. The study will establish a research basis to make recommendations to Piedmont growers on conservation tillage practices and the use of cover cropping and compost.

Specialty Crops in Rotation of Cover Crops, Nitrogen Management and Sustainability

Principal investigator: **Dr. M.R. Reddy**

The results of the experiment suggest that sweet corn can be grown at half the recommended nitrogen rate when winter cover cropping is practiced, without affecting yield, thus reducing the cost of corn production while minimizing environmental harm. The project also shows that two specialty melon cultivars, Sprite and Sun Jewel, could provide net income of \$2,000 to \$4,000 per acre.

Treatment of Swine Wastewater and Herbicides in Constructed Wetlands for Water Quality

Principal investigator: **Dr. G.B. Reddy**

This recently completed study verified that constructed wetlands are effective in treating swine wastewater when used in conjunction with spray field application. Data indicate that by including constructed wetlands in the waste management system, swine farmers can reduce acreage for spray fields and also avoid phosphorus accumulation. The project also indicates that floating wetlands or mechanical aeration will not improve the efficiency of wetlands.



These future leaders were in the spotlight last spring at the SAES Child Development Laboratory graduation ceremony. The Laboratory has been extended from a nine-month program to a year-round learning resource for researchers, and graduate and undergraduate students, as well as the young scholars.



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