Growing North Carolina's Agricultural Biotechnology Landscape

Successes, Challenges and Strategies

August 2009

AGRICULTURAL BIOTECHNOLOGY

Executive Summary

Just as every season brings new life to the farm, every year brings new opportunities and tools to the fast-moving agriculture industry. Some things, however, don't change: year after year, agriculture remains one of North Carolina's largest industries and a way of life for many of its people. North Carolina's agricultural sector, including food, fiber and forestry, brings $70.1 billion to the state every year. These revenues account for 18 percent of the state's income. Across North Carolina, 700,000 people—approximately 18 percent of the workforce—are part of the business of agriculture.

Although many states boast of a well-developed agriculture sector, North Carolina farms are distinct. Average farm size is much smaller in our state than in the nation as a whole—164 acres compared with 418 acres. Yet the net income per farm is higher in North Carolina—$58,478 vs. $41,810—than the U.S. average. It's clear that North Carolina farmers are savvy at business and crop management.

But new competition and challenges require new tools for even these savvy farmers to succeed in the marketplace. With its deeply rooted emphasis on research and education and its agriculture tradition, North Carolina is primed to leverage the tools of biotechnology to create that advantage.

Already, successes are evident from the mountains to the coast. In the last two years, the North Carolina Research Campus in Kannapolis and the Biofuels Center of North Carolina in Oxford opened. The most acres of crops enhanced by biotechnology were planted. Breakthroughs in research improved animal agriculture, nutrition, food safety, energy and the environment.

All contribute to a vibrant, growing sector that will transform North Carolina's agricultural heritage into its future.

Biotechnology brings exciting and lucrative opportunities that accompany the changing, challenging landscape of modern agriculture.

North Carolina's model for biotechnology development and its application to agriculture

Wanting North Carolina to be at the forefront of a new technology, the state in 1984 created the North Carolina Biotechnology Center to stimulate the biotechnology economy and create jobs.

The Biotechnology Center's mission is to provide long-term economic and societal benefits to North Carolina by supporting biotechnology research, business and education statewide. The Center accomplishes this mission via its five statewide offices in Asheville, Charlotte, Greenville, Winston-Salem and Wilmington and headquarters in Research Triangle Park.

The Biotechnology Center works with all aspects of biotechnology, and many of its resources have been devoted specifically to agricultural biotechnology. (See page 7)

North Carolina as a Leader in Agricultural Biotechnology

Bio-based economy: An economy that uses renewable raw materials and biotechnology to produce products and energy.

Resources and Foundations

North Carolina's farmers grow many economically important agricultural products and rank first in the nation in the production of many food, fiber and forestry products. In the east, farmers raise sweet potatoes, watermelons, hogs, tobacco, cotton and many other important crops. In the west, agriculture-related industries thrive, including the forestry industry and harvesting medicinal herbs from the wild, called wild-crafting.

North Carolina has promoted the link between biotechnology and agriculture and the results are clear: a thriving industry sector that receives strong support from academic, educational, government and private entities.

More than 70 agricultural biotechnology-related companies employ more than 4,000 people in the state. These companies include major multi-national corporations, such as Bayer CropScience, Syngenta, Monsanto and BASF; established biotechnology companies such as Embrex, purchased by Pfizer Animal Health; and small entrepreneurial ventures such as BioResource International. (See page 14 for a full list.)

Because agricultural biotechnology is driven by innovation, it naturally clusters around top research universities.

North Carolina has world-class research in agricultural biotechnology at multiple institutions. In addition, North Carolina's teaching institutions are committed to agricultural education. The North Carolina Community College System recently announced a focus on agricultural biotechnology as part of its BioNetwork program, which connects biotechnology education programs across the state. BioNetwork established its Center for BioAgriculture at Robeson Community College.

North Carolina has a strong, long-standing government agency devoted to agriculture support, the Department of Agriculture and Consumer Services (see page 11). North Carolina also has a unique opportunity with the establishment of the world-class North Carolina Research Campus (see page 13).

What is Agricultural Biotechnology?

Biotechnology is a broad collection of tools and technologies that use living cells and/or biological molecules to solve problems and make products. Agricultural biotechnology is the application of biotechnology to agriculture and its products: the food we eat, the clothes we wear and other everyday products we use. It has the potential to produce more food, fiber and commodities at lower cost and with less environmental impact.

Improvements made by Agricultural Biotechnology

	Category	Specific Example
1	Resistance to harmful environmental factors such as insects, agricultural chemicals (including herbicides and pesticides), viruses and other diseases	Bt cotton, Round-up Ready™ soybeans
2	Modification of existing characteristics such as growth rate, fruit size or drought resistance	BioResource International
3	Added nutritional value such as increased vitamin content or increased inherent nutrition	Golden Rice increased Vitamin A content, NCRC research
4	Completely new trait/biopharming such as plants or animals that make therapeutic products	Ventria's rice

The tools and technologies of biotechnology have three main applications:

- Creating new crops
- Making tools to improve agriculture
- Finding new uses for old crops

Each of these categories includes a broad range of opportunities for the agricultural community to add value to what it is already doing. Following is an overview of each category, and how it is important to North Carolina.

Creating New Crops

Ever since humans began cultivating crops instead of hunting and gathering food, we have been improving our food's quality. Until recently, this meant taking seeds from crops with the best characteristics and planting those seeds the next year.

As we've learned more about DNA—the molecule in every cell that gives the instructions for life—we understand better, for example, why some corn tastes sweeter and why squash plants resist some viruses. These traits are associated with genes, pieces of DNA that give a plant or animal specific traits.

Today we can insert into a plant cell a gene that carries a beneficial trait. That gene can come from the same type of plant, from a different plant or even from an animal. For example, a gene from citrus fruit may allow potatoes to grow in soil with high levels of acidity. Plants that have been developed in this manner are generally referred to as genetically modified. The table at the left shows selected examples of these improvements.

These changes aren't just to fresh produce; they are part of many processed foods we buy regularly. For example, the corn chip, found in supermarkets across the U.S., contains multiple ingredients that are likely to have been made from genetically modified plants, as shown at left.

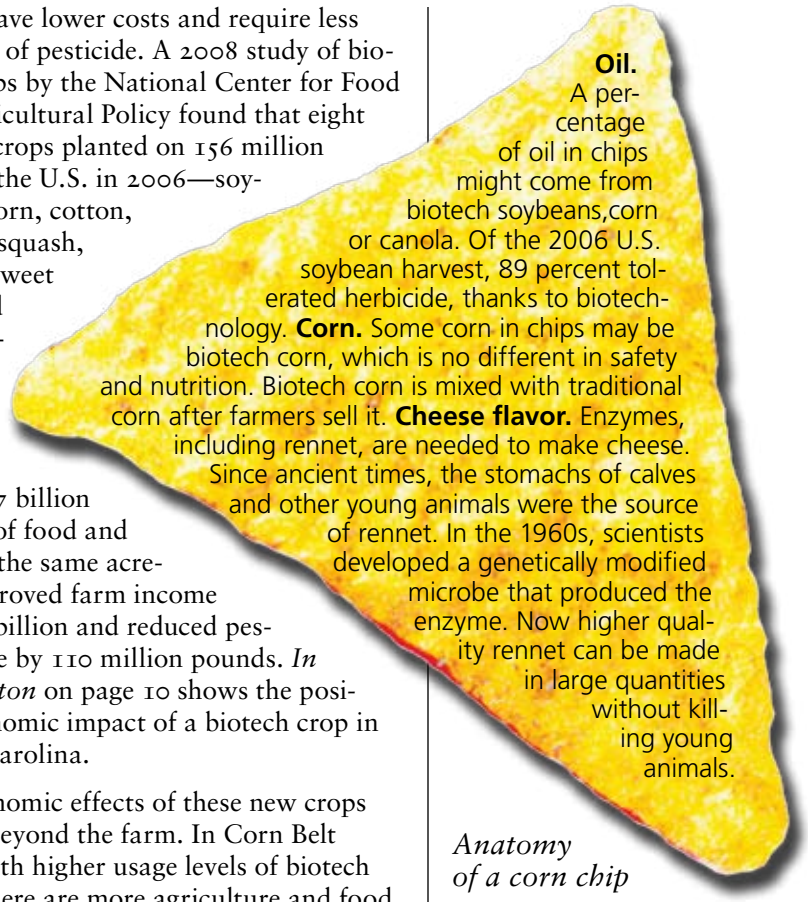
Most of the biotech crops now on the market have been improved to make them resistant to harmful environmental factors. Therefore, many farmers have deliberately chosen to plant biotech crops for very simple reasons: biotech crops give higher yields, have lower costs and require less spraying of pesticide. A 2008 study of biotech crops by the National Center for Food and Agricultural Policy found that eight biotech crops planted on 156 million acres in the U.S. in 2006—soybeans, corn, cotton, papaya, squash, alfalfa, sweet corn and canola—produced an additional 7.7 billion pounds of food and fiber on the same acreage, improved farm income by $2.6 billion and reduced pesticide use by 110 million pounds. *In Tall Cotton* on page 10 shows the positive economic impact of a biotech crop in North Carolina.

The economic effects of these new crops extend beyond the farm. In Corn Belt states with higher usage levels of biotech crops, there are more agriculture and food science jobs than in states with lower levels of adoption.

Making Tools to Improve Agriculture

The second application of biotechnology to agriculture is to add value to agricultural commodities or decrease the effort required to produce them. Like creating new crops, this type of agricultural biotechnology is already widespread and growing rapidly. Uses include animal vaccines, growth hormones, antibiotics, fertility applications, characterization of crop traits, feed additives and many other applications. (How biotechnology tools are used to improve feed additives is described more extensively on page 8.)

Animal vaccines are a great example of biotechnology applied to agriculture. Vaccines that protect commercially grown fish from disease can result in a much greater yield. Biotechnology tools have been widely used in the research laboratory to help create many new animal vaccines against diseases costly to the farmer.



Anatomy of a corn chip

In North Carolina, biotechnology tools have also been used to improve the way vaccines are delivered. A quarter-century ago, newborn chickens had to be vaccinated by hand. A North Carolina company developed a tool, using biotechnology, that circumvents that difficult task and still protects chickens from disease. Read more about the invention on page 12 in the story *Of Chickens and Eggs*.

Biotechnology tools will help agriculture in many ways, some of which are yet to be foreseen. In the future, biotechnology tools will touch just as many lives as tools of the information technology industry touch today.

Ventria Bioscience

Kansas-based Ventria Bioscience is using Washington County farmland to grow rice that is adapted to produce two specialized proteins containing some protective characteristics found in mother's milk. It's part of a new opportunity for farmers to step beyond production of basic food and fiber, and to harvest crops categorized as nutraceuticals – foods containing therapeutic benefits.

The Ventria rice, after processing, is being tested as a possible supplement to liquid baby formula to reduce the severity of diarrhea among children. Children get these benefits while they are being nursed. But baby formula doesn't contain these proteins, so the protection is lost when nursing is no longer possible. In developing nations, diarrhea is deadly for many thousands of babies each year.

Greg Unruh, vice president and general manager for Ventria, says the company is not only excited about the lifesaving potential of its rice, but also about the chance to work with state and national regulators interested in incorporating Ventria's operating procedures into guidelines for other crops.

For more information, visit *www.ventria.com*.

Finding New Uses for Old Crops

Biotechnology is applied to agriculture in a third way—developing new uses for traditional crops. This is called industrial biotechnology and it begins with agriculture, using a renewable resource such as corn, soybeans, or other type of biomass as the starting material.

For example, corn can be processed into its components: protein, starch, oil, fiber, and lignin. After additional refining and synthesis the components become three products with three different uses—fuel, industrial chemicals, and pharmaceutical intermediates.

This application of agricultural biotechnology is not specifically tied to genetic modification. In the future, though, food crops may be specifically modified for industrial uses. For instance, soybeans could be genetically engineered for higher soybean oil production versus plant protein content, useful in biodiesel fuel production.

Both the chemical industry and the energy sector are pursuing industrial applications of biotechnology. Chemical industry products made via biotechnology processes include alcohols, fine chemicals, organic acids, amino acids, enzymes, flavors, and fragrances. These products generate sales of around $300 million annually. The potential market for bio-based materials is up to $1 trillion.

The energy sector is taking a closer look at biotechnology, particularly to make ethanol production more efficient. With a recent increased focus on green energy, ethanol has become a viable alternative to gasoline. However, using vast amounts of corn for gasoline production has an impact on the food supply. Some companies are looking at non-food biomass as a starting point for ethanol, and industrial bioprocessing may hold the key to producing it efficiently. Those technical advances are being worked on by Novozymes, which has its North American headquarters in Franklinton, N.C. Federal government support for ethanol plant construction may further boost this sector.

Moving ideas to market: putting agricultural biotechnology to work for North Carolina

North Carolina has become a leader in agricultural biotechnology because it has made the right investments to move biotechnology innovations from research to row crop. This section looks at the work of the North Carolina Biotechnology Center and its partners to provide grants, loans and education and networking opportunities to grow the state's agriculture sector.

Generating new ideas

Scientific innovations that can eventually lead to new companies and jobs are essential for North Carolina's economic prosperity. University research is the primary source of these ideas and drives new businesses and job creation. The most immediate payoff comes from applied research, but even basic research can ultimately lead to commercial products. North Carolina universities conduct some of the world's foremost agricultural biotechnology research. Nurturing this scientific discovery and building infrastructure are critical to growth and innovation.

A total of $13.3 million in agricultural biotechnology funding was awarded through multiple Biotechnology Center programs from 1984 to 2008. Funding was distributed through two broad categories: grants to North Carolina universities and loans to North Carolina companies.

Overview of Biotechnology Center agricultural grant funding

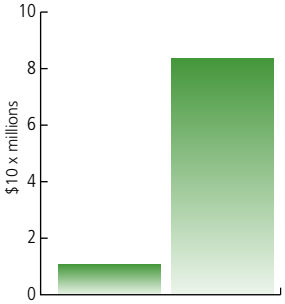
The Biotechnology Center made more than 170 awards in agriculturally related research to universities from 1984 to 2008 through its Science and Technology Development Program. Total additional funding spurred by the $10,867,864.27 awarded is $83,695,532, or $7.70 for every dollar invested. The Biotechnology Center has funded early stage research projects that may be pivotal for future innovation in agricultural biotechnology. Following are summaries of two such projects that are having early stage commercial success.

Seedless Success

Nursery crops have been the fastest-growing agricultural sector in North Carolina during the last 25 years. The wholesale value of these crops exceeded $1 billion in 2006, with North Carolina producing more than 6 percent of total sales in the U.S. The future growth potential for the state in this sector is also very strong because North Carolina includes diverse climates that are ideal for growing a tremendous range of nursery crops. However, one issue in the nursery industry is invasive exotic plants. Due to high demand, many of these species are produced and sold; however, they are a biodiversity threat second only to habitat destruction. The development of non-invasive varieties would be an ideal solution.

This is the problem that Tom Ranney, Ph.D., of the Mountain Horticultural Crops Research and Extension Center has been working on in partnership with Hoffman Nurseries in Rougemont, one of the foremost producers of ornamental grasses in the U.S. Using tools of biotechnology, Dr.

Agriculture Awards Through 2008 to North Carolina Universities

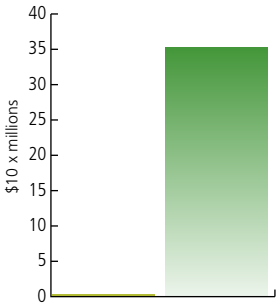


Total of Grants Awarded
$10,867,864.27

Total Follow-on Funding
$83,695,532.00

The EPA has officially approved BioUD™ as a safe, active ingredient in insect repellent for direct skin application with no child safety restrictions.

Agriculture Awards Through 2008 to North Carolina Companies



Total amount awarded to agricultural and nutraceutical companies by the Biotechnology Center

$2,444,454

Total amount of follow-on funding from other sources

$352,355,540

Ranney is developing a new, seedless variety that can be grown commercially using a plant tissue culture micropropagation system.

This and other collaborations between companies and researchers are funded through the North Carolina Biotechnology Center's Collaborative Funding Grant program.

Safer Insect Repellent Developed at NC State

Michael Roe, Ph.D., William Neal Reynolds Distinguished Professor of Entomology at NC State, has discovered that a substance produced by tomatoes repels mosquitoes and other insects more effectively and more safely than DEET, the chemical most commonly used in insect repellants. The natural compound is so effective that the university patented the substance and licensed the right to produce it as an insect repellent.

The U.S. Environmental Protection Agency estimates that one-third of Americans use DEET. While the EPA has deemed DEET safe for adults, products containing DEET have recently been relabeled to promote caution about its use for children.

Now, the wait for a DEET-free, child-safe insect repellent is over. The EPA has officially approved BioUD™—a result of Roe's research—as a safe, active ingredient in insect repellent for direct skin application with no child safety restrictions. HOMS, a North Carolina-based biotech company, will immediately begin distribution of the BioUD™ formula in a product called Bite Blocker®.

Funding for Roe's research was provided in part by the Biotechnology Center.

Overview of Biotechnology Center agricultural loan funding

Creating new ideas is only the beginning of agricultural economic development. The ways in which technology is transferred from universities into practical use is at the heart of the biotechnology economy. Biotechnology Center business assistance and loan programs are designed to facilitate this process, and provide very early stage support for young companies that are taking new technologies to market.

Over the years, the Biotechnology Center has made 24 loans or grants totaling $2.4 million to agricultural and nutraceutical companies though its Business and Technology Development Program. These companies have secured $352 million in follow-on funding from other sources, or $144 for each dollar invested by the Biotechnology Center.

Not just chicken feed

One success story of the loan program shows how a single enzyme can have a profound effect. Directly adding the enzyme Versazyme™ to poultry feed increases chicken body weight by improving the digestibility of proteins. Academic and commercial proof-of-concept trials have shown that feed costs can be reduced by using the enzyme. The market potential for Versazyme™ is predicted to be upwards of $200 million globally.

In addition to its uses as a direct feed additive for poultry, Versazyme™ has a wide variety of other agricultural and industrial applications, including feed manufacture, food processing, waste management,

detergents, cosmetics, leather processing, animal care products, nutraceuticals, biomedical research, and forensics.

It was the Biotechnology Center that provided early funding for BioResource International and NC State to investigate how Versazyme™ works. The results of those studies led to a new company, 10 U.S. and international patents, and hundreds of thousands of dollars in federal funding.

Scientific Collaboration

In addition to funding new research, the Biotechnology Center also brings scientists together to share ideas. The Plant Molecular Biology Consortium brings together academic and industrial scientists to discuss research at the molecular level. This forum has thrived for almost two decades with participation from hundreds of scientists, as well as generous corporate sponsorships.

Teaching the teachers

The Biotechnology Center reaches across the state every year to teachers who are eager to learn more about agricultural biotechnology topics. The Summer Workshops for Educators have reached more than 1,450 North Carolina teachers, who in turn have taught hundreds of thousands of North Carolina students. These Biotechnology Center-sponsored workshops have included: Introductory Biotechnology, Biotechnology for Plants, Animals and the Environment (which includes current techniques in animal husbandry, applications of plant science and environmental protection), and Forensic DNA from the Irish Potato Famine Pathogen.

The workshop on the Irish potato famine is easy to relate to modern agriculture, given that the potato is ranked 17th in major North Carolina farm commodities and had 2006 cash receipts of $31 million.

The Biotechnology Center has also funded the development of courses in agricultural biotechnology, including Biotechnology and Agriscience Research I, a high school course that was part of the Career and Technical Education curriculum, as well as a middle school course on Exploring Biotechnology that has an agricultural component.

The Biofuels Center of North Carolina

The North Carolina General Assembly funded the Biofuels Center of North Carolina in 2007 to spearhead development of a statewide biofuels industry and reduce the state's dependence on imported liquid fuels—currently estimated at about 5.6 billion gallons a year. The Center, based in Oxford, teams with academic, agricultural, civic and other leaders across the state to ensure that by 2017, 10 percent of that amount will be biofuels grown and produced locally, primarily from non-food sources that might include wood and animal wastes and specialty grasses.

More information is available at *biofuelscenter.org*.

Issues Surrounding Agricultural Biotechnology

Agricultural biotechnology is increasingly involved in the foods we eat, the clothes we wear and other products we use everyday.

Agricultural biotechnology holds extraordinary promise for North Carolina. But like any new technology, it faces challenges in gaining acceptance and prominence as part of the state's economy.

Societal Issues

Advances in agricultural biotechnology carry many potential benefits for farmers, food processors, consumers and the environment. But with these advances also come questions surrounding the science that makes them possible.

This is hardly surprising, for few subjects are as important as agriculture, food, and our uses of the land on which we live. Some of those topics include food safety, consumer use and acceptance, animal welfare, sustainability, genetic transference, potential loss of biodiversity, and land use and conservation.

Chief among those questions is food safety. Before foods developed with biotechnology can be marketed in the United States, there

In Tall Cotton: Biotech crop rejuvenates farming in eastern North Carolina

Milton Prince of Belhaven had grown corn, wheat, and soybeans on his Beaufort County farm since the 1970s. But when American consumers turned from synthetic clothing to natural fibers in the 1980s, he added cotton to the mix.

He started on a small scale in 1991, but the rich, dark soil—known as the Black Lands—had other ideas. It sprouted cocklebur, morning glory, pigweed, sicklepod, smartweed and other weeds that overtook the cotton, stunting his crop yields.

"I fought that thing for four years," Prince recalled. "I was about to throw in the towel. We really had no herbicides to control weed pressures."

Then along came new cotton varieties genetically engineered to resist herbicides. Growers could apply herbicides that would kill the weeds, but spare the cotton plants. It was a revolutionary advance for growers like Prince.

"These genetically engineered cultivars gave us the opportunity to grow cotton and control weeds effectively," he said. "Without biotechnology, cotton would not be grown in this area today—no question about it."

Today, roughly 65,000 acres of biotech cotton are grown in Beaufort County and neighboring Hyde, Tyrrell and Washington counties, an enormous increase from the 1,000 acres grown in 1991. Biotech cotton has become so profitable that Prince no longer grows soybeans and other crops. All of his 2,700 acres are planted with biotech cotton that resists the environmentally friendly but broadly effective herbicide Roundup.

To process all the locally grown biotech cotton, Prince and nine other growers joined together in the late 1990s to build two cotton gins—one in Beaufort County and one in Hyde County. The $10 million investment in Coastal Carolina Cotton Gins has boosted the tax base of both counties and created 10 full-time jobs and another 48 seasonal jobs.

About the NCDA&CS

The Research Station Division of the North Carolina Department of Agriculture and Consumer Services has 18 locations statewide. Each provides land, buildings and staff to support research in region-specific crops, trees, livestock, poultry and aquaculture. Each station has a unique combination of weather patterns and soil composition, reflecting the diversity of the environments faced by farmers across North Carolina.

North Carolina's Research Stations represent some of the state's unparalleled foundation of capabilities: fields and land, research and education facilities, and smart farmers. Critical to the future and continued success of agricultural biotechnology in North Carolina is the active engagement, partnership, and collaboration with the state's Research Stations and their rich and diverse resources.

are nine separate steps in the regulatory process that typically take seven to 10 years to complete—a far more rigorous process than is required for conventional foods.

Many organizations, including the American College of Nutrition, the American Medical Association, the International Society of Toxicology, the General Accounting Office of the U.S. Congress, and the World Health Organization have attested to the safety of foods developed with biotechnology.

Still, certain interest groups as well as some consumers continue to have concerns about genetically modified foods. This has commercial impact, because some markets (the European Union and Japan among them) have previously resisted biotech crops. Issues of food safety and genetic modification highlight the many questions surrounding the science and application of agricultural biotechnology. These questions must be addressed thoughtfully, comprehensively, and collaboratively.

Competition

Competition for biotechnology growth and development is intense nationally and internationally. Forty-one states have initiatives in biotechnology to support economic growth, and some of those states have chosen to focus on the agricultural sector.

North Carolina also faces rising competition from other countries. Chinese policymakers consider agricultural biotechnology as a strategically significant tool for improving national food security, raising agricultural productivity, and creating a competitive position in international agricultural markets. Brazil is also aggressively adopting biotechnology. The South American nation is a huge producer of genetically modified crops that compete with U.S. commodities. North Carolina must anticipate the future of agricultural biotechnology and provide the right environment for its growth to remain competitive with other states and nations.

Natural products for Western North Carolina

The Western Office of the Biotechnology Center helped form a collaboration between the North Carolina Arboretum, UNC-Asheville, the Mountain Horticultural Crops Research Station, and the North Carolina Natural Products Association. This coalition launched the Bent Creek Institute, which is using scientific techniques to build a natural products industry in Western North Carolina based on the region's exceptional biodiversity.

Reasonable Regulation

North Carolina has created and maintained a consistent and transparent regulatory environment to attract and retain agricultural biotechnology companies. The recent report from the Pew Initiative on Food and Biotechnology indicates that biotech companies are more inclined to move to states that provide well-structured regulatory climates. This report also praised North Carolina as a leader in this area and commended the North Carolina Department of Agriculture and Consumer Services for its work in regulatory affairs.

North Carolina's work in regulation goes back two decades. In response to a request for a field test of a genetically modified crop, the Biotechnology Center brought together 29 North Carolinians representing industry, government, the environment, and research. The committee spent a year drafting the first consensus-based legislation for testing genetically modified field crops. This legislation later served as a model for federal regulations. This consensus model will prove beneficial as North Carolina moves forward with its agricultural biotechnology efforts.

Of chickens and eggs

Just 25 years ago in the poultry business, newborn chicks were vaccinated by hand, a cumbersome and expensive method that was also stressful to the birds. Today many poultry hatcheries around the world use an automated egg-injection system to vaccinate poultry in ovo, or in the egg. The system, developed by Embrex Inc. of Durham, saves time and money and gets the chicks off to a healthier start. Throughout the U.S. and Canada, more than 80 percent of broiler birds raised receive their vaccines against Marek's disease this way.

Founded in 1985, Embrex received key initial funding from the Biotechnology Center for its research and development. The company went on to raise $14 million in venture capital and gain $27.5 million in two public stock offerings. Two private placements in 1991 and 1995 raised an additional $5.5 million. Today, Embrex is part of Pfizer Animal Health and employs many engineering and poultry science graduates of North Carolina State University. In addition to its Durham research location, Pfizer Animal Health operates a vaccine-production plant in Laurinburg.

Growing North Carolina's Agricultural Biotechnology Landscape

Context and Imperative

Agriculture has always been North Carolina's largest industry, as well as a way of life for many of the state's residents. Modern agriculture, a fast-moving and challenging industry, has changed dramatically in recent years to include the application of biotechnology to agriculture. Agricultural biotechnology is increasingly involved in the foods we eat, the clothes we wear and other products we use everyday. It has the potential to produce more food, fiber and other commodities at lower cost and with less environmental impact.

With strong research and education, rich agricultural tradition and progressive farmers, North Carolina is taking a leadership position in agricultural biotechnology.

Shaping Long-Term Strategy

To shape this opportunity while addressing the issues of agricultural biotechnology, 100 North Carolinians representing various geographic areas, constituents and perspectives met as the *Advisory Committee: Growing North Carolina's AgBiotech Landscape*.

Leading this effort were Gov. James B. Hunt Jr. and the Biotechnology Center's W. Steven Burke, now president and CEO, Biofuels Center of North Carolina.

Project Outcomes

The committee's consensus report presents strategies for increasing the agriculture industry by $30 billion over the next 10 years by:

- Developing a multi-party team dedicated to agricultural biotechnology advancement;
- Building upon existing institutional resources and strengthening partnerships;
- Implementing commercialization models for research and applications of agricultural biotechnology;
- Developing marine, animal, niche, specialty and value-added crops and markets to create a chain of agriculture clusters across the state of North Carolina; and
- Targeting and addressing the education continuum from curriculum based education to workforce training to the general public.

The advisory committee, Growing North Carolina's AgBiotech Landscape, issued recommendations in the summer of 2009.

North Carolina Research Campus

Created by billionaire David Murdock, the North Carolina Research Campus in Kannapolis is dedicated to human health and nutrition research. With more than a million square feet of lab and office space so far, the campus features some of the most advanced scientific equipment in the world. University and private company researchers are putting the tools of biotechnology to work to enhance nutrition, fight cancer and improve health around the globe.

Our partners in this venture

A state strong in agricultural resources provides an unusually wide range of organizations and experience. Project and Advisory Committee members from key vantage points will serve as partners and advisors. Project partners and the North Carolina Biotechnology Center will engage during the coming year in related activities to strengthen agricultural biotechnology research, business, and education across the state.

Partners and Links

Avoca, *www.avocainc.com*

Athenix, *www.athenixcorp.com*

BASF Plant Science, *www.basf.com/plantscience*

Bayer CropScience, *www.bayercropscience.com*

Bent Creek Institute, *www.bentcreekinstitute.org*

Biofuels Center of North Carolina, *www.biofuelscenter.org*

Coastal Carolina Gin, *www.coastalcarolinagin.com*

The Conservation Fund, *www.conservationfund.org/southeast/northcarolina*

Golden LEAF Foundation, *www.goldenleaf.org*

Institute of Forest Biotechnology, *www.forestbiotech.org*

Joe Landino Farms

Murphy-Brown East, *www.murphybrownllc.com*

NC Agricultural and Technical State University—School of Agriculture and Environmental Sciences, *www.ag.ncat.edu*

The NC Arboretum, *www.ncarboretum.org*

NC Biosciences Organization, *www.ncbioscience.org*

NC Biotechnology Center, *www.ncbiotech.org*

NC Community College System—BioNetwork, *www.ncbionetwork.org*

NC Department of Agriculture and Consumer Services, *www.ncagr.com*

NC Farm Bureau Federation, *www.ncfb.org*

NC Forestry Association, *www.ncforestry.org*

NC General Assembly, *www.ncleg.net*

NC Research Campus, *www.ncresearchcampus.net*

NC Rural Economic Development Center, *www.ncruralcenter.org*

NC Soybean Producers Association, *www.ncsoy.org*

NC State University—College of Agriculture and Life Sciences, *www.cals.ncsu.edu*

NC State University—College of Natural Resources, *www.cnr.ncsu.edu*

NC State University—College of Veterinary Medicine, *www.cvm.ncsu.edu*

Syngenta, *www.syngenta-us.com*

Tobacco Trust Fund Commission, *www.tobaccotrustfund.org*

US Department of Agriculture—Rural Development *www.rurdev.usda.gov/nc*

University of North Carolina, *ww.northcarolina.edu*

University of North Carolina Wilmington—Center for Marine Science, *www.uncw.edu/cmsr*

North Carolina's Biotechnology Industry

North Carolina has more than 70 ag biotech-related companies employing more than 4,000 workers in the state. These companies include major multi-national corporations, established biotechnology companies, and small entrepreneurial ventures. (Please note that some companies fall into multiple categories.)

Ag Biotech

Agile Sciences
American Agricultural Services
Athenix
BASF Plant Science
Bayer CropScience
Cotton Inc.
GrassRoots Biotechnology
Monsanto
Mycorrhiza Biotech
PhytoMyco Research
SePRO Research
Syngenta Biotechnology
Venganza

Plant-Derived Pharmaceuticals

Agarigen
Biolex
SoyMeds
Ventria

Nutraceuticals/Herbs

Alderon Biosciences
Algaen
Avoca
Bent Creek Institute
Biogaia Biologics
Botanics Integrated
Gaia Herbs
Gene Smart Health
Muscadine Naturals
PhytoPharmacon

Marine

Aqualutions
Biolume
Norcarex Bio
SePRO Research
World Ocean Solutions
Zuzu Bioceuticals

Animal/Veterinary

Advanced Animal Diagnostics
AviFluVax
BioResource International
Galaxy Diagnostics
Gene Smart Health
Goldsboro Laboratories
Greer Laboratories
GT Callison
Happy Jack
IDEXX Pharmaceuticals
IDEXX Reference Laboratories
ImmunoBiosciences
Mycosol
Novartis Animal Health
Pfizer Poultry Health
Piedmont Pharmaceuticals

Pesticide/Fungicide

Arysta LifeScience North America
BASF Crop Protection
Bayer CropScience
Chemtura USA
EntoGeneX
Fair Products
Makhteshim Agan of North America
Mycosol
NuFarm Americas
SipcamAdvan
Syngenta Crop Protection

Industrial/Environmental/Biofuels

Alditri Technologies
Alganomics
American Distillation
Applied MicroProducts
Athenix
BioTech Mills
BioTrackers
Carbon-to-Liquids Development Center
Dupont
EcoFuels
EnSolve Biosystems
Entex Technologies
Novozymes
Xenobiotic Detection Systems

Foods

Ajinomoto
Archer Daniels Midland
Axitare
Bendiner Technologies
Corn Products International
Gene Smart Health
Nitta Gelatin
Novozymes

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