ABSTRACT

Development of entrepreneurial environments in southeastern North Carolina by the University of North Carolina at Pembroke through the Thomas Family Center for Entrepreneurship and the Biotechnology Research and Training Center is threefold (education, consulting, and research). Academic programs have been created through the Thomas Center to provide entrepreneurial education. Both centers work with regional partners to promote entrepreneurship and scientific training. The Thomas Center provides business consulting and regional entrepreneurship summits. The Biotechnology Center provides agricultural research environments, where innovation is demonstrated by the commercialization of organic products such as beneficial nematodes and natural honey bee products. Beneficial nematodes are produced as biopesticides against agricultural insect pests. Additionally, they will also be used to protect honey bees. Finally, rearing and marketing of honey bee queens will provide additional research support to sustain this project.

Robeson County and Surrounding Areas

The University of North Carolina at Pembroke (UNCP), the UNCP Thomas Family Center for Entrepreneurship, and the UNCP Biotechnology Research and Training Center are located in Robeson County. Robeson is the largest county in the state of North Carolina and is located in the Coastal Plains of Southeastern North Carolina. Based on the 2000 Census, its multiracial population of 123,339 is 38% Native American, 32% Caucasian, 25% African American, and 5% Latino/Hispanic. The Asian population is less than 1%. Robeson County is home to the Lumbee tribe, the largest Native American tribe east of the Mississippi River with nearly 60,000 members (Town of Pembroke 2008). Robeson County is also the poorest county in the state, with a poverty rate of 32% (MSN Money 2012).

The implementation of General Agreement on Tariffs and Trade (GATT) and the North American Free Trade Agreement (NAFTA), has meant the displacement of thousands of rural North Carolina workers. Robeson County has felt the brunt of economic restructuring. Between 1997 and 2009, Robeson County lost nearly 9,000 jobs, representing 41% of its manufacturing jobs. This predominantly rural county has seen significant increases in unemployment, crime, poverty, and bankruptcies with substantial reductions in household income and business tax revenue. Teen pregnancy and school dropout rates continue to be high. Surrounding counties have also experienced similar problems, with the neighboring Scotland County losing three major manufacturers and three smaller firms, leaving it with the highest unemployment rate in the state at nearly 17%. The state economic rating system ranks seven of
the ten counties in the UNCP service area as tier 1 (most in need of economic development) (Charles et al. 2012).

The University of North Carolina at Pembroke
The University of North Carolina at Pembroke (UNCP) was established in 1887 as the Croatan Normal School in response to a petition from the native Indian people of the area. The school opened with 15 students and one teacher in the fall of 1887. It was founded to train American Indian public school teachers. Now, the University of North Carolina at Pembroke is one of 16 campuses that comprise the University of North Carolina system. UNCP offers 45 BA and 17 MA degrees, with a total enrollment of over 6,000 students.

The Thomas Family Center
The Thomas Family Center (TFCE) was founded in 2006 by James A. Thomas and the Thomas Family to improve the economic and social conditions in Robeson County by (1) encouraging entrepreneurship among current citizens; (2) training students to open and run small businesses; (3) providing assistance to existing business; (4) working to address social problems; and (5) attracting new businesses to the area. The Thomas Family Center works with area community colleges, local and state government entities, civic organizations, associations, and public schools to encourage economic and community development.

The TFCE has a professional staff of three. Graduate and undergraduate students are employed and trained as business assistants. The Executive Director is responsible for center policies and actions of the TFCE. The Thomas Family Distinguished Professor heads academic entrepreneurship programs which include: (1) a certificate program; (2) a minor for non-business majors; (3) a concentration leading to a BS in Business Administration; and (4) an entrepreneurship track in the MBA program. The Distinguished Professor’s additional responsibilities include consulting, outreach, and research. The third professional staff member serves as a business consultant who assists the center’s staff, students, and area businesses.

Through much of its history, rural North Carolina has been home to merchants, Native American artisans, and progressive farmers, all willing to take necessary risks to build their businesses. Southeastern North Carolina has been negatively impacted due to the decline in tobacco agriculture. The two other significant areas of industry, before the movement of companies away from the region, were furniture-making and textiles. Downtown small businesses, region-wide, have suffered greatly due to the loss of industry. Many downtowns have vacant buildings or buildings that cannot accommodate new small business ventures. However, larger companies able to afford renovations can occupy vacant mills and plants (Daniel's Bakery, Pembroke, NC). To address these crippling factors, the Thomas Family Center strives to stimulate small business development to create jobs and build community
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wealth. The TFCE recognizes that rural communities have a strong history of entrepreneurial success and a powerful work ethic on which to build a base for future prosperity.

The TFCE supports the business community by providing one-on-one consulting and evaluation services while helping students develop entrepreneurial competencies and knowledge. The result extends entrepreneurship beyond the classroom by allowing students to work with local entrepreneurs on critical business challenges. Experiential learning is a great tool for training entrepreneurship students. At the same time, local businesses benefit from the knowledge and innovative ideas provided by the students (Menefee and Holmes 2012). The Thomas Family Center was established to catalyze the recruitment to and development of businesses in the UNC Pembroke service region. UNCP is one of the largest employers in Robeson County, and the economic impact made by the Thomas Center continues to progress. The TFCE plays a crucial role in attracting regional investments through: 1) training; 2) employment opportunities; and 3) business education. Evidence of the TFCE's efforts is the ongoing development of the UNCP Biotechnology product, Brave-Guard, which will be described below. Brave-Guard is a prime example of UNCP's continued investments in regional scientific development.

The NCIIA/UNCP Partnership
UNCP joined NCIIA as a member institution in 2009. In 2010, UNCP was awarded a one-year Planning Grant to help build the two year old entrepreneurship program and to attract matching funds for the TFCE and the Biotechnology Center. The grant money and matching funds were used to educate the campus and community about the value of entrepreneurship, to purchase a camera and microscope for the nematode project, to promote entrepreneurship research, purchase more bee hives, and support faculty travel to professional meetings.

NCIIA awarded UNCP a Course and Program Grant for two years (2011-2013). This grant and matching funds are being used to (1) enhance the entrepreneurship program; (2) purchase a shaking incubator for the nematode project; (3) support project prototyping; (4) purchase research supplies for honey bee research; (5) hire consultants for research projects; (6) help form e-teams; and (7) support faculty research and travel.

Biotechnology Research and Training Center
The University of North Carolina at Pembroke provides leadership, education, and advocacy to make Southeastern North Carolina the best place to live, work, and visit. The UNCP Biotechnology Facility provides a “theory-into-practice” environment for:

• Education and training
• Research
• Technology transfer
• Regional economic transformation

This 5,000 square foot facility consists of laboratories for fermentation, chemistry, molecular biology, and other life science technologies. The UNCP Biotechnology Research and Training Center has the capacity to address re-
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search problems in most sectors of biotechnology: agricultural, biomanufacturing, environmental, and biomedicine. The center is conjoined with the UNCP Regional Center for Economic, Community, and Professional Development within the Carolina Commerce and Technology Park (COMtech). The center has two major corporate sponsors: Farm Bureau of Robeson and Sartorius-Stedim Biotechnology. These sponsors support the emphasis of the center: agricultural biotechnology.

The core activity of the Biotechnology Center is to conduct innovative agricultural research. Research outcomes include training opportunities, technology transfer, and product development. These outcomes will strengthen relationships between the university and private sectors. In addition, research faculty at the center are involved in efforts to promote entrepreneurship and agricultural biotechnology. The center has collaborated with agencies of the Indian government (Ministry of Science and Technology, Ministry of Human Resource Development, and Indian Council of Agricultural Research) to host six Indian research scientists from 2010 to the present. Dr. Len Holmes, the center's director, serves on the advisory board for the North Carolina Biotechnology Center to promote agricultural biotechnology throughout Southeastern North Carolina.

Specific goals of the center are: (1) to increase the availability of a trained workforce; (2) to increase job opportunities for underrepresented populations; and (3) to offer entrepreneurs technology and business support. The UNCP biotechnology facility houses laboratories, classrooms, and offices for faculty, students, and academic and industrial partners. Laboratory spaces include:

- Microbiology/Molecular Genetics Laboratory
- Analytical Quality Control-Assurance Laboratory
- Biochemistry and Preparative Laboratory
- Bench-to-Pilot Scale Fermentation Suite
- Research/Visiting Researcher Laboratory

The labs are equipped to conduct research with special emphasis on the biology and production of beneficial nematodes and honey bees and related products. The center holds state of the art fermentation equipment to support the nematode project and other microbial studies. Fermentation is the term used to describe any process for the production of a product by means of culturing cells or microorganisms, and is the first step in many biotechnology processes. Organic and biological molecules, microbes, therapeutics, enzymes, antibiotics, and vaccines are all produced through fermentation technology. Students who are trained in bioprocessing and fermentation technology are well equipped for promising employment in the biotechnology industry (Menefee and Holmes 2012).

Mass Production of Beneficial Nematodes

In an effort to reduce widespread use of potentially harmful chemical pesticides, researchers at the biotech facility are working to develop technologies for mass producing nematodes that are parasitic toward plant insect pests. Currently, researchers at the center are studying two nematode (roundworms) species, *Heterorhabditis bacteriophora* and *Steinernema carpocapsae*. 
These nematodes can be mass-produced in fermentation systems with their microbial partners, *Photorhabdus luminescens* and *Xenorhabdus nematophila*, respectively. The economic potential of producing and marketing beneficial nematodes is significant, as there are only a handful of companies globally that have the technologies to mass-produce these biocontrol agents. The technology is proprietary and complex; therefore, the production approach involves fermentation technology and knowledge of nematode, bacterial, and insect biology.

The Biotechnology Research and Training Center possesses the necessary equipment and instrumentation to conduct this research from bench-scale to pilot-scale. Elucidating the complex relationship between the roundworms and their bacterial partners will maximize the mass production process (Inman, Singh, and Holmes 2012). In partnership with area farmers, the nematodes will be field-tested for efficacy, safety, and effective application. Currently, the biotech center uses a scanning electron microscope (SEM) jointly owned by UNC Pembroke and Fayetteville State University to obtain high-quality images leading to a better understanding of nematode-bacteria interactions. Fermentors and online instruments allow the researchers to study the bacteria to maintain nematode growth and development. Additionally, the nematode project provides excellent opportunities to engage undergraduate research students in “real-world and relevant research.” Nematodes, as biocontrol agents, are minimally regulated by the USDA, FDA, and EPA (Ehlers 1996). It is important to note that these nematodes do not adversely impact humans or non-target organisms.

**UNCP Honey Bee Research**

This project addresses the importance of honey bees to the environment and to the economy of the state. Honey bee Colony Collapse Disorder (CCD) is decimating the vitality and abundance of honey bees, which are crucial to the pollination of trees, fruit, grains, and grasses. Factors that affect honey bee survival include: (1) loss of habitat; (2) use of chemical pesticides; (3) loss of plant biodiversity; and (4) disease. Honey beekeeping is declining at a steady rate. As the number of farmers and persons entering agriculture decrease, the number of regional beekeepers decline. The UNCP Honey Bee Project promotes the art and business of regional beekeeping. The honey bee industry serves as a $6M market annually for North Carolina, and is crucial to North Carolina agriculture, as honey bees are the most important crop pollinators. From 2006-2011, honey bees have accounted for 68% in annual fruit and vegetable production and approximately 25% in total crop productivity. The state of North Carolina exports honey bees and bee-related products nationally. The industry is promoted, monitored, and regulated by the North Carolina departments of Commerce and Agriculture. COMtech Park has partnered with the UNCP Biotechnology Center to establish a 15-acre bee yard. A new project initiative is the rearing and sales of honey bee queens, for which there is an enormous national demand due to Colony Collapse Disorder and natural disease.

During the past two years, the university has gifted, sold, and established many hives to farmers, gardeners, and university faculty. Hives have been placed at high schools and community college campuses. Regional FFA and 4H Clubs have visited the biotech center for programs highlighting beekeeping. Regional community colleges utilize their hives for pollination of plants...
propagated by their biotechnology and horticulture students. The UNCP Honey Bee Research Park has maintained over 30 hives over the past two years. The center regularly consults with master beekeepers and the Robeson Beekeepers Association to promote the science and art of beekeeping. The center provides funding for honey bee-related research. UNCP students have presented beekeeping-related research at state-wide conferences and symposia. As evidence of how highly the university regards this project, the Chancellor has adopted a hive at his residence on campus. Future honey bee initiatives include the use of beneficial nematodes for hive protection from insect pests and infectious honey bee diseases. The Research Park plans to focus research on rearing queen honey bees for commercialization, as the need for queen bees is increasing.

The Current Situation
The Biotechnology Center has now acquired the technology to commercialize beneficial nematodes. Production scale-up is our next challenge. Scale-up will require further investment of appropriate equipment, skilled scientists, and process operators. The university has seen the potential of the nematode project and supports it by employing three full-time research scientists dedicated to the development of the UNCP Biotechnology product, Brave-Guard. Brave-Guard and its production technology are in the process of being patented to protect UNCP investments. We are grateful to the NCIIA for funding that has provided the necessary shaking incubator to expand our scientific capabilities. The honey bee project continues to promote beekeeping and fundamental research.

The TFCE continues to serve both the community and the University. A course on Invention and New Product Development has been proposed and is now under review. Yearly summits have been established for community entrepreneurs and students to increase their knowledge and management skill levels. Two elevator competitions have been established for students with entrepreneurial ambitions where the prize money ($2,000) was raised from outside support. The university has provided “Hawk Assistantships” for aspiring University students to work with area companies at the TFCE and the biotechnology center. Finally, $350,000 was raised for a new incubator for business development in the town of Pembroke. The entrepreneurship program now has over thirty graduates, 160 students enrolled, and four new business start-ups.

References


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