The Mission of the N.C. Bioenergy Research Initiative (BRI) is to support the research and development of agricultural and forestry-based feedstocks for bioenergy production, agribusiness development and cooperative research for biofuels production.

The 2013 North Carolina General Assembly appropriated funds to the Research Stations Division of the N.C. Department of Agriculture & Consumer Services to support the developing bioenergy industry in North Carolina.
Across the country there has been growing interest in replacing petroleum-based transportation fuels with bio-based alternatives. Although the production of ethanol from corn has ramped up in the Midwest, converting corn into ethanol in North Carolina, a corn-deficit state, is considered unfeasible. However there is interest in converting purposefully grown crops into cellulosic ethanol in North Carolina. The theory is that perennial grasses and fast-growing trees can be grown on currently underutilized land, and be profitable to farmers.

**BRI supported this focus on bioenergy crops with its first four grant cycles:**
- Genetic improvement and selection.
- Establishment methods.
- Weed management.
- Nutrient uptake, usage and removal.
- Harvest management including methods, timing, transporting and storage.
- Stand management such as renovation for productivity, planting dates, crop management, and eradication when necessary.
- Physiology, growth, and development of biomass energy crops.
- New species with bioenergy potential.
- Multiple crop production practices such as crop rotation, double-cropping, and intercropping.

BRI has invested $3.5 million to award 45 grants focusing on bioenergy research.

**OVERVIEW OF MISSION**

Many of these production disciplines have been addressed through a large project located on three swine farms in southeastern North Carolina. Switchgrass, giant miscanthus and biomass-type sorghums have been planted on sprayfields associated with the waste management of swine production. These grasses can produce an abundant supply of low-cost feedstock for cellulosic ethanol production. Based on yield and nutrient uptake data from this project, the N.C. Interagency Nutrient Management Committee created nutrient recommendation guidelines for growing bioenergy grasses targeted toward realistic yield expectations. Several other projects have focused on establishment methods and timing, weed management, harvest timing and storage of biomass materials.

Interest in growing feedstock for cellulosic ethanol production led a local entrepreneur to develop a mechanized system for the harvesting, washing, sorting and planting rhizomes to establish giant miscanthus, a warm season, fast-growing perennial grass. Several thousand acres have been planted in southeast N.C. Even though the technology for cellulosic ethanol has not fully developed, the company has established a market for the biomass by using it in poultry houses for bedding. The spent bedding can then be used for energy or applied to land for organic matter and nutrients.

Previous research focused only on the Illinois clone of giant miscanthus and there was little known genetically about this naturally occurring sterile organism. Few researchers, if any, were working on genetic improvement.
BRI has funded multiple projects to bring viability into giant miscanthus seed, make genetic crosses and develop improved sterile plants. Through this research, yields from new hybrids have already surpassed what is commercially available now.

Similar work is being conducted in the sugarcane family by crossing exotic species to develop high-yielding, cold-hardy sterile organisms that can be used as bioenergy feedstocks. These biomass crops also have potential to be used for forage, fiber applications and animal bedding, in addition to cellulosic ethanol. Research is currently addressing genomics and bioengineering in these crops. In the long-term, additional bioengineering may be utilized to produce novel, high-value metabolites such as oils, bioplastics and spider-silk proteins to further enhance their value, application and commercialization.

**FROM FIELDS TO FOREST**

Another area of BRI-funded feedstock research is production of woody biomass from the forest. Woody biomass primarily comes from two sources: (1) logging residues such as fuel chips recovered during conventional timber harvesting and (2) short rotation woody crops. Logging residues are inexpensive, available at large scale and are being used in large biomass boilers for power or steam production. Logging residues are already being harvested as energy feedstocks throughout much of the Coastal Plain and Piedmont. An early project in Eastern North Carolina funded by BRI, demonstrated that logging residues can be harvested without detrimental effects on wildlife. BRI is currently funding similar research in Western North Carolina on wildlife impacts. Fuel chip markets help improve forest management for private landowners while providing additional income and reducing available fuel for wildfires. Chips can be converted into pellets as another form of wood for fuel.

Short rotation woody crops (SRWCs) are fast growing trees that can be harvested for energy in a fraction of the time of conventional forest crops. They offer high growth rates of biomass and produce a very uniform feedstock for biofuels conversion. Various SRWC research has been funded by BRI with the overall objective of developing systems that produce the greatest volume of biomass per acre per year at the lowest cost. This will improve the bottom line to growers and attract them to SRWC production as markets develop.

**Objectives of the research have included:**

- Comparison of species for SRWC production and comparison of various poplar (Populus spp.) clones (40+ planted in BRI projects);
- Evaluations of planting techniques and spacings;
- Evaluations of cost effectiveness of fertilization rates;
- Development of a North Carolina SRWC productivity model;
- Use of a GIS approach to identify location of appropriate sites for purpose-grown energy crop establishment in NC including grasses and SRWCs;
- Development of an online SRWC financial tool for landowners;
- Development of a poplar intercropping system to co-produce bioenergy feedstocks and high value hardwood plywood veneer.

Although still under way, research has produced models and tools that allow landowners to select species or clones for maximum growth on their land. These tools will provide estimated cash flows and rates of return based on feedstock price assumptions.
FROM FOREST TO FUEL

BRI became interested in the comparison of using wood pellets versus propane as a heating fuel. This interest began when the Carolina Land & Lakes Resource Conservation and Development Council visited a poultry farm in Kentucky where the grower was heating broiler houses with furnaces that burn wood pellets. The Council applied for a BRI grant to evaluate energy costs savings of heating with wood pellets verses propane. In addition to fuel-costs savings, wood pellet burning systems produce a drier atmosphere than propane. In poultry production, less humidity reduces ammonia in these houses which leads to lower mortality rates in chicks. Less ammonia also leads to larger body weight and better feed conversion in poultry. These factors equate to higher profits for the farmer. Wood pellets are preferred over chips because of qualities such as consistency, ease of mechanical handling and less ash production. To prove this concept in NC, BRI has funded a Carolina Land & Lakes research project over four grant cycles to install wood pellet burning systems on five poultry farms located in four western N.C. counties.

This project has also been the catalyst for a Piedmont lumber company to install wood pellet production equipment. That company is currently producing 5,000 tons of high quality wood pellets annually that are being used for heating fuel as well as for animal bedding.

The ultimate outcome of this project is threefold: (1) to develop a use for forest and lumber residues, as well as purposefully grown trees, (2) to stimulate a wood pellet manufacturing industry and (3) increase profitability of poultry farms.

OUTREACH

Each year, BRI hosts a field day showcasing the promising research being conducted on bioenergy/biomass crops to the public. This field day alternates between the Mountain Horticultural Crops Research Station in Mills River, representing the western part of the state, and NC State University’s Williamsdale Field Laboratory in Duplin County, representing the eastern side of the state. In total, more than 380 individuals have attended these events.