

**V(A). Planned Program (Summary)**

**Program # 4**

**1. Name of the Planned Program**

Sustainable Energy including Biotechnology

Reporting on this Program

**V(B). Program Knowledge Area(s)**

**1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
202	Plant Genetic Resources	15%	10%	15%	20%
205	Plant Management Systems	15%	20%	20%	20%
401	Structures, Facilities, and General Purpose Farm Supplies	5%	10%	5%	0%
402	Engineering Systems and Equipment	20%	10%	20%	20%
403	Waste Disposal, Recycling, and Reuse	20%	20%	15%	20%
404	Instrumentation and Control Systems	10%	10%	10%	0%
511	New and Improved Non-Food Products and Processes	15%	20%	15%	20%
	<b>Total</b>	100%	100%	100%	100%

**V(C). Planned Program (Inputs)**

**1. Actual amount of FTE/SYs expended this Program**

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	7.0	2.0	10.0	5.0
Actual Paid Professional	22.0	2.0	19.0	8.0
Actual Volunteer	1.0	0.0	0.0	0.0

**2. Actual dollars expended in this Program (includes Carryover Funds from previous years)**

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
214252	100149	275880	665593
1862 Matching	1890 Matching	1862 Matching	1890 Matching
214252	93227	275880	363799
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1649348	0	2141141	2307017

### V(D). Planned Program (Activity)

#### 1. Brief description of the Activity

- Developing productive efficient systems to profitably produce a variety of crop and forestry based substrates for biofuels production
- Developing engineering solutions and systems to efficiently convert raw materials into useable fuels
- Exploit bioprocessing systems to produce a variety of compounds that might have utility in processing and manufacturing processes
- Advance or knowledge of energy use and conservation in human, agricultural, animal and processing environments
- Communicate solutions and systems to users through extension education and demonstration activities
- Further study of cattails as a feedstock for biofuels

#### 2. Brief description of the target audience

Scientists, commercial and limited resource farmers, regulatory entities, homeowners, general public, agribusinesses

#### 3. How was eXtension used?

eXtension was not used in this program

### V(E). Planned Program (Outputs)

#### 1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	2108	5634	0	0

#### 2. Number of Patent Applications Submitted (Standard Research Output)

**Patent Applications Submitted**

Year: 2012  
 Actual: 3

**Patents listed**

Process For Conversion Of Biomass To Fuel(Mexico)

Process For Conversion Of Biomass To Fuel(US)

Expression of Extremophile Enzymes as Co-products From Biofuel-producing Algae and Cyanobacteria

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2012	Extension	Research	Total
Actual	0	46	46

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Studies on producing agricultural and forestry substrates for biofuel production

Year	Actual
2012	25

**Output #2**

**Output Measure**

- Studies on engineering conversion processes for biofuels and other components

Year	Actual
2012	25

**Output #3**

**Output Measure**

- Educating homeowners, growers and processors through workshops and other group educational approaches on sustainable energy topics

Year	Actual
2012	1500

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	New crops or other biofuels substrates identified
2	New bioprocessing technologies developed
3	New bioproducts identified
4	Number of households improving energy conservation measures
5	Installation of energy saving strategies on animal and crop production facilities

## **Outcome #1**

### **1. Outcome Measures**

New crops or other biofuels substrates identified

### **2. Associated Institution Types**

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

### **3a. Outcome Type:**

Change in Action Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	2

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Animal wastes can cause water and air pollution without proper treatment. These wastes can also be used as a feedstock for biofuel production.

#### **What has been done**

NCA&T researchers conducted studies on the hydrothermal processing of swine manure and other waste materials (e.g., duckweed, crude glycerol and waste vegetable oil) into bio-oils in a Parr reactor.

#### **Results**

Co-hydrothermal processing of swine manure and crude glycerol resulted in a significantly high bio-oil yield (~68%), which was upgraded to produce a suitable composition and quality of biofuel for transportation use.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
202	Plant Genetic Resources
205	Plant Management Systems
511	New and Improved Non-Food Products and Processes

## **Outcome #2**

### **1. Outcome Measures**

New bioprocessing technologies developed

### **2. Associated Institution Types**

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

### **3a. Outcome Type:**

Change in Action Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	1

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Microalgae may represent a promising biofuel feedstock. However, a microalgae cultivation system should (1) control environmental factors that affect growth, such as temperature, (2) mix multiple-phases of algal cells, nutrients, CO<sub>2</sub>, O<sub>2</sub> and water, (3) prevent contamination and (4) minimize water loss due to evaporation.

#### **What has been done**

A 100-liter photobioreactor to grow microalgae on swine wastewater was designed and built on the NCA&T farm. The photobioreactors provides a controlled environment to test microalgae cultivation year around.

#### **Results**

A Ph.D. student in computational science and engineering is developing a computational fluid dynamic (CFD) model to improve the design and operation of the photobioreactor for better efficiency and economics of the growth of microalgae on swine wastewater.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

### **Outcome #3**

#### **1. Outcome Measures**

New bioproducts identified

#### **2. Associated Institution Types**

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

#### **3a. Outcome Type:**

Change in Action Outcome Measure

#### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	1

#### **3c. Qualitative Outcome or Impact Statement**

##### **Issue (Who cares and Why)**

A bioproduct from hydrothermal processing of swine waste is bio-oil which can serve as a raw material for the production of adhesives and phenol formaldehyde-type resins.

##### **What has been done**

NCA&T researchers developed a biobinder from bio-oil for use in pavement material.

##### **Results**

The biobinder will improve petroleum-asphalt binder's low temperature properties, resulting in the reduction of asphalt pavement construction costs. The cost of biobinder production is estimated to be \$0.13/L (\$0.54/gal), which is more favorable than that of fossil-based binder at \$0.53/L (\$2/gal).

#### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

## **Outcome #4**

### **1. Outcome Measures**

Number of households improving energy conservation measures

### **2. Associated Institution Types**

- 1862 Extension
- 1890 Extension
- 1862 Research

### **3a. Outcome Type:**

Change in Action Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	1500

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Residential energy conservation measures can lower family home heating and cooling costs, which can be particularly important for low-income households.

#### **What has been done**

The E-Conservation Energy Education Program teaches citizens to save energy, lower homeowner energy utility costs and protect North Carolina's environment by reducing pollution and greenhouse gas emissions. The program informs and educates North Carolina consumers about ways to both reduce energy use and increase energy efficiency in the home. E-Conservation reaches and teaches consumers to be proactive in reducing their home energy consumption and in saving money through no-and low-cost energy efficiency measures, behavioral changes and home retrofits.

#### **Results**

County Cooperative Extension agents across the state provide direct services to NC citizens by conducting outreach workshops; disseminating materials such as fact sheets, newsletters and consumer energy kits; partnering with local utilities and municipalities to maximize energy resources; offering energy audits, and assisting in the overall evaluation of the program. Previously, the E-Conservation program provided professional home energy audits for consumers, utilizing North Carolina green businesses. This ability to offer audits was suspended when funding stopped at the end of 2011; however, it will be offered again between 2012 and 2014.

### **4. Associated Knowledge Areas**

**KA Code**    **Knowledge Area**  
402            Engineering Systems and Equipment

**Outcome #5**

**1. Outcome Measures**

Installation of energy saving strategies on animal and crop production facilities

**2. Associated Institution Types**

- 1862 Extension
- 1890 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	85

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**

During winter, thermal energy requirements increase production costs for greenhouses.

**What has been done**

A biomass hot water heating system was used for a Harnett County, North Carolina greenhouse operation producing tomatoes and tobacco transplants. Instrumentation was installed to quantify the energy requirements for the production of greenhouse tomatoes and tobacco transplants.

**Results**

During the fall, winter and early spring, supplemental heat is needed in the greenhouses to maintain the optimal production temperature for the plants. Replacing LP gas with biomass greatly reduces the production cost. The data collected will be used to assist in specifying system components for other installations.

**4. Associated Knowledge Areas**

**KA Code**    **Knowledge Area**  
402            Engineering Systems and Equipment

## **V(H). Planned Program (External Factors)**

### **External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

### **Brief Explanation**

Rapidly changing environmental and economic conditions (weather extremes, economic climate) influence producers abilities to adapt to change while ensuring sustainable production systems and environments. Continued effects of the economy on federal, state and local support for research and extension programs continue to challenge our research and extension enterprises. Likewise, regulatory and other governmental policies and rules influence the educational and research capacities of our programs and present challenges to producers, processors and marketers to comply with new and often expensive regulations. And in an environment and reduced funding, the program competition for existing funds becomes a greater challenge to manage. Nevertheless, emphasis is placed on those research and extension opportunities that have the greatest effect on sustainability of farms, families and businesses, i.e., economic, environmental and social and quality of life viability.

## **V(I). Planned Program (Evaluation Studies)**

### **Evaluation Results**

Information in this report is compiled from North Carolina Cooperative Extension reporting system, faculty activity reports and impact statements, Office of Technology Transfer and the business offices at the two institutions. The data indicate that, despite continuing budget challenges, our research and extension programs continue to reach significant segments of our audience with relevant research and extension information that has benefit to their enterprises. Based on the impact statements, publications and patents filed, our research and extension faculty on the two campuses and across the state continue to foster and lead change.

### **Key Items of Evaluation**

Research and demonstration projects and activities are focused both on strategies to reduce fossil fuel use through conservation, use of biofuels, proper construction techniques and other factors to move to reliance on more sustainable energy sources, including solar and other alternative uses. Specific research in the college is aimed to create new energy crops for biofuel production, discover new technologies to enhance the conversion of biosubstrates to renewable fuel sources, and to exploit known and new processes leading to production of biofuels and related coproducts that may have high value.