

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Climate Change

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
102	Soil, Plant, Water, Nutrient Relationships	20%	40%	20%	20%
111	Conservation and Efficient Use of Water	5%	20%	5%	5%
112	Watershed Protection and Management	15%	10%	10%	10%
133	Pollution Prevention and Mitigation	10%	10%	10%	10%
141	Air Resource Protection and Management	5%	10%	5%	5%
401	Structures, Facilities, and General Purpose Farm Supplies	5%	0%	5%	5%
402	Engineering Systems and Equipment	5%	0%	5%	5%
403	Waste Disposal, Recycling, and Reuse	10%	0%	10%	10%
404	Instrumentation and Control Systems	5%	0%	5%	5%
405	Drainage and Irrigation Systems and Facilities	5%	0%	5%	5%
605	Natural Resource and Environmental Economics	15%	10%	20%	20%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	55.0	4.0	25.0	6.0
Actual Paid	68.0	2.5	24.0	1.8
Actual Volunteer	8.0	0.0	4.0	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
1203121	108807	425805	277886
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1203121	23160	425805	86302
1862 All Other	1890 All Other	1862 All Other	1890 All Other
4385359	5775	3050600	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research will focus on creating new knowledge and solutions from basic research (e.g., nutshell-based activated carbons), to agricultural production systems research, to natural resource pollution prevention strategies, to examining people's attitudes and concerns about environmental issues and policies, including economic considerations. With this research information in hand, improved management, technological solutions and policies to environmental and natural resource utilization problems will be proposed and evaluated with farmers, businesses, stakeholders and communities. Technology transfer will occur through demonstrations, workshops, and various media from Cooperative Extension in concert with researchers.

2. Brief description of the target audience

Agricultural producers, environmental and governmental agencies, news media, general public, limited resource audiences, rural appraisers, commodity associations

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	51435	61866	0	0

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

Patent Applications Submitted

Year: 2014

Actual: 1

Patents listed

Novel Methods and Compositions to Evaluate and Determine Inactivation of Hazardous Biological Material. 61/969,465

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	18	73	91

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Waste Management Certification Programs

Year	Actual
2014	10

Output #2

Output Measure

- Number research project completed on environmental/natural resource issues

Year	Actual
2014	95

Output #3

Output Measure

- Number of non-degree credit environmental activities conducted

Year	Actual
2014	400

Output #4

Output Measure

- Enrollees for Natural Resources Leadership Institutes training

Year	Actual
2014	20

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of farms utilizing precision application technologies
2	Number farms implementing best management practices for animal waste management
3	Number urban households/small farms with low-literacy individuals implementing or adopting best management practices to enhance water quality
4	Number waste management certifications gained or maintained
5	Number acres where proper waste analysis was used for proper land application
6	Number growers implementing stream protection practices
7	Number storm water systems installing BMPs
8	Number farms adopting use of biofuels
9	Number growers implementing improved irrigation and drainage systems

Outcome #1

1. Outcome Measures

Number of farms utilizing precision application technologies

2. Associated Institution Types

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

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The next generation of precision agriculture technology ? Unmanned Aerial Systems (UAS) ? could have dramatic impact on grower productivity statewide.

What has been done

Scientists in NCSU?s Biological and Agricultural Engineering Department are exploring applications of UAS in precision agriculture and environmental engineering. Evaluation of the aerial platforms and sensor payloads available are underway. UAS offers a wide range of sensor options, many of which are not currently available to agricultural producers on a routine basis.

Results

This research could result in the ability to fly over agricultural fields on demand, capture data, and make management decisions on crops with a short turnaround time (unlike satellites and manned aircraft, which take longer). Drones will allow greater flexibility with data collection and create opportunities that aren?t currently available, potentially improving precision agriculture practices statewide.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #2

1. Outcome Measures

Number farms implementing best management practices for animal waste management

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1974

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The ammonia in manure and waste treatment systems is dilute and therefore limited in use to relatively short distances, usually on the same property on which the animals are raised. In North Carolina and much of the country, this prevents use of the valuable nutrients in the feed production system.

What has been done

NCSU engineers have built a pilot scale ammonia recovery reactor system based on technology developed by USDA-ARS that can remove 50% of the total ammoniacal nitrogen in a lagoon sample over a period of several days. In cooperation with ARS, these scientists will develop procedures that will facilitate on-farm operation.

Results

Development of this technology will help convert the pollution potential of liquid manure application into a valuable fertilizer product that can be transported out of the local watershed. Once developed, this technology will provide business and employment opportunities in many rural communities associated with animal production. Statewide, 1,974 animal producers adopted Extension-recommended best management practices for animal waste management, utilizing 2.4 million tons of livestock organic byproducts. By using livestock organic byproducts instead of synthetic fertilizers, growers statewide realized a net income gain of \$35 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management

Outcome #3

1. Outcome Measures

Number urban households/small farms with low-literacy individuals implementing or adopting best management practices to enhance water quality

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Growers use excessive tillage and do not implement agricultural practices that increase soil carbon content.

What has been done

Reduced tillage practices, the application of compost and the growing of summer and winter cover crops are being evaluated by NCA&T scientists as practices that sequester carbon and increase soil carbon content.

Results

Field experiments have been implemented and soil samples collected for determining stability of soil carbon fractionation and analyses. Laboratory analyses are being conducted to determine carbon fractions and fraction stability.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #4

1. Outcome Measures

Number waste management certifications gained or maintained

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1895

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Animal waste management is a large part of livestock production in Bladen County. Producers must comply with many rules and regulations to protect the environment. Swine farmers must comply with conditions in their permit to stay in compliance with the Division of Water Resources.

What has been done

Bladen County Cooperative Extension provides assistance to swine producers, poultry producers and septic tank owners on sludge management, irrigation calibration, litter calibration, record-keeping, manure sampling, general permits and nutrient management plans.

Results

Extension helped 14 producers perform sludge surveys on 31 lagoons and seven producers calibrate equipment systems, which saved these producers almost \$9,000. Additionally, 200 acres in Bladen County are now under nutrient management plans to ensure they are protecting the environment. Statewide, 1,900 waste management certifications were gained or maintained due to Extension education efforts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management

Outcome #5

1. Outcome Measures

Number acres where proper waste analysis was used for proper land application

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1041537

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Poultry production is North Carolina's largest agriculture sector, accounting for 35.8% of total cash receipts. Commercial poultry production results in large volumes of manure and bedding material, referred to as poultry litter. While litter is a waste byproduct to poultry growers, crop farmers can utilize litter as an excellent fertilizer, thus reducing or replacing their use of commercial fertilizers, usually at a cost savings. Waste management plans are required by General Statutes to protect water quality, and they help farmers to utilize the nutrients in the litter to maximize benefits for the crops.

What has been done

Extension delivered waste management plans for new and expanding growers in four counties. Producers were trained in proper record keeping, sampling and handling regulations to protect water quality and maintain compliance with the NC Division of Water Resources.

Results

As a result of these efforts, 22,500 tons of litter these farms generate should be utilized to maximize crop production and preserve water quality. Statewide, Extension-recommended waste analysis was used for proper land application on more than 1 million acres.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #6

1. Outcome Measures

Number growers implementing stream protection practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	124

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Sedimentation of streams, lakes and other waters in North Carolina is considered to be the state's primary pollutant. Population growth brings more urban areas, increasing storm water volumes and velocities delivered to smaller local streams eroding the stream banks, the primary source of the sediment. Traditional methods of stream-bank stabilization (walls, rip rap, gabion baskets, etc.) are failure-prone.

What has been done

Working with state and county environmental agencies, Extension specialists, city-town officials, environmental groups, property owners, landscapers, and Triangle J Council of Governments, a statewide team of Extension agents developed and delivered hands-on workshops in Wake and Durham Counties during 2012-2014 reaching over 100 participants in workshops and an additional 17,113 through photos and videos viewed on social media sites.

Results

Property owners, landscapers, environmental groups and city-town officials report implementing stream-bank stabilization practices saving over 725 tons of sediment annually from entering streams in Wake and Durham Counties. Other results: a property owner reported saving over \$25,000 and 90 tons of soil by installing practices he learned at Extension workshops; 2 towns reported stabilizing over 1,200 feet of stream-bank: a landscaper avoided possible fines totaling over \$50,000 by installing stream vegetation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #7

1. Outcome Measures

Number storm water systems installing BMPs

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rain water running off impervious surfaces creates flooding and pollutes the nation's streams and rivers. NCSU's Storm water BMP Inspection and Maintenance Training Program trains and certifies people to inspect and maintain practices such as wetlands, ponds, swales, and permeable pavement to prevent flooding and control pollution.

What has been done

More than 2,200 people have been certified in Storm water BMP inspection and maintenance and many return after 3 years to a recertification class to learn about new developments in storm water management. At the recertification class each person completes a survey to determine how many storm water practices they design, install, inspect, or maintain.

Results

Respondents reported the following practices under management: 383 bioretention beds retaining \$828,000 of Nitrogen and \$734,000 of Phosphorus; 1,702 ponds converting \$1,752,000 of Nitrogen and \$1,933,000 of Phosphorus; 179 wetlands retaining \$1,769,000 of Nitrogen and \$1,220,00 of Phosphorus; and 399 vegetated swales converting \$985,000 of Nitrogen and \$679,000 of Phosphorus. Additionally, in an example from Watauga County, Extension worked with the First Presbyterian Church of Boone to construct a stormwater wetland that captures and mitigates more than 8 acres of impervious surface. Extension was able to save the church \$1,000 in vegetation costs by growing more than 500 plugs that volunteers planted throughout the quarter-acre wetland.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #8

1. Outcome Measures

Number farms adopting use of biofuels

2. Associated Institution Types

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

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Agro-industrial residues and dedicated biomass crops contain complex carbohydrates that can be converted to high value products (e.g. food products, pharmaceuticals, biochemicals, biopolymers and biofuels). The development of biologically-based methods for converting and processing raw materials into higher value products that are cost effective and functional integration of processing/production steps along the supply chain (e.g. feedstock development, production systems, logistics, and end use) will increase the feasibility of using plant/crop based resources as additional feedstocks for consumer goods.

What has been done

The research program focuses on production of bio-based products, such as enzymes, biochemicals, and biofuels from agro-industrial residues and dedicated biomass crops. Several areas make up the program to address the diversity of renewable resources available and various processing methods that can be applied to generate products and enhance value, such as: semi-solid fermentation technology, enzymatic conversion methods and fermentation for development of effective biomass conversion processes, hybrid application of thermal and microbial conversion technologies for biofuel production from lignocellulosic biomass, and solvent extraction processes are also being investigated for biomass materials that contain natural colorants, nutraceuticals and other high value compounds.

Results

Other value-added products from the sweet sorghum crop have been demonstrated through ensilage and feedout studies and have shown promise as a near-term markets for the biomass crop as energy related applications gain momentum. Fermentation studies with adapted *C. beijerinckii* strain SA1 for butanol production using sugars derived from sweet sorghum and perennial grasses are providing key information for the next phase of 'advanced' biofuels. Anthocyanin compounds from the purple sweet potato can be extracted as a co-product of starch to sugar conversion. Among producers statewide, four growers adopted dedicated bioenergy crops on 49 acres.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies

Outcome #9

1. Outcome Measures

Number growers implementing improved irrigation and drainage systems

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Improved drainage is essential for production of food, feed, and fiber in many parts of the U.S. including the midwest states and the coastal region of North Carolina. There is a critical need to sustainably maximize the productivity of drained land to meet the increasing demand for food and biomass for biofuel production. There is also a critical need to adapt agricultural production systems on drained land to predicted changes in the climate including changes in temperature and precipitation (amounts and timing).

What has been done

A variety of strategies and systems have been evaluated to enhance water control, drainage water management, and management of Nitrogen and Phosphorous export, as it relates to crop land and forest land.

Results

The research addresses local, national, and global needs, responds to emerging changes in land uses and management practices, and focuses on adapting crop production systems on drained lands to a changing environment. Specific outcomes include: 1. The development of the smart agricultural water management system including the automated drainage water control structure will lead to the revitalization of controlled drainage in eastern NC where large areas of agricultural lands are artificially drained. This will result in a potential increase in crop production, reduction in production cost, conservation of water, and substantial improvement in surface water quality. 2. The results of our research have shown that both controlled drainage and bio-reactor systems have the potential to be used as BMPs for reducing nutrient export from drained spray fields. Our

research could lead to the adoption of these two practices by the state of North Carolina to reduce nitrogen losses to surface waters from land application of animal waste to drained fields. 3. The ongoing research on growing bio-energy crops will lead to a better understanding of the impacts of growing these crops on water quantity, quality, and C and N cycling. This is necessary for the evaluation of the sustainability of growing bio-energy crops on lands that are not used for food production. 4. The DRAINMOD suite of models are being used by many researchers in the U.S. and abroad to assess the long term effects of emerging changes in land uses and management practices on the hydrology and biogeochemistry of agricultural and forested lands with improved drainage. Models such as DRAINMOD are particularly essential at this time for predicting the response of agricultural and forest ecosystems to potential changes in the climate and assessing strategies for adapting agricultural and forest production systems on drained land to these changes in the climate.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

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 economic and environmental conditions influence producers' and communities capacities to adapt to change and at the same time, sustain their operations. Water supplies for irrigation, high cost of fuels, and harsh weather systems present significant challenges all too often. Changing federal, state local funding commitments for research and extension programs are challenged regularly. And regulatory and other governmental policies challenge the entire community, which our research and extension programs serve. Nevertheless, we are committed to ensuring that programs that endure are those that will have significant economic, environmental, social and quality of life benefits to our stakeholders.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Examination of the outcomes and impacts in this program area indicate significant progress and benefit in the areas of waste management, nutrient capture and utilization, and water quality protection, along with some of the economic benefits that accrue to those outcomes. As pressures increase for access to large quantities of irrigation water, it is anticipated that our research and extension programs will need to play a greater role in providing technology and systems to manage that water efficiently to optimize crop and food production, use nutrients efficiently and conserve water.

Key Items of Evaluation

Our strong programs in water quality and animal waste management and utilization continue. Our evaluation approaches are not collecting sufficient data and information on outcomes and impacts from our research and extension on irrigation and drainage systems and their benefits to farmers, communities and other land managers. We will strive to make changes in our evaluation tools to capture that information.