V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Environment, Energy & Climate

☑ 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	12%		14%	
111	Conservation and Efficient Use of Water	10%		4%	
112	Watershed Protection and Management	10%		7%	
123	Management and Sustainability of Forest Resources	5%		5%	
124	Urban Forestry	2%		2%	
125	Agroforestry	2%		4%	
131	Alternative Uses of Land	5%		3%	
132	Weather and Climate	0%		3%	
133	Pollution Prevention and Mitigation	5%		3%	
135	Aquatic and Terrestrial Wildlife	5%		4%	
141	Air Resource Protection and Management	2%		1%	
201	Plant Genome, Genetics, and Genetic Mechanisms	5%		2%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	5%		22%	
204	Plant Product Quality and Utility (Preharvest)	7%		5%	
206	Basic Plant Biology	0%		2%	
211	Insects, Mites, and Other Arthropods Affecting Plants	8%		6%	
306	Environmental Stress in Animals	5%		2%	
402	Engineering Systems and Equipment	2%		3%	
511	New and Improved Non-Food Products and Processes	5%		5%	
605	Natural Resource and Environmental Economics	5%		3%	
	Total	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	18.3	0.0	25.0	0.0
Actual Paid	15.8	0.0	164.0	0.0
Actual Volunteer	1.1	0.0	2.6	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**
306616	0	717891	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
311931	0	14304984	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2259642	0	2611402	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Sustaining water resources is important to all Arkansans and all citizens have a responsibility to help protect both the quality of soils, waters and watersheds. Amid nonpoint source pollution concerns, agricultural producers in Arkansas are facing increasing pressure to reduce sediment and nutrients from leaving their farms. Livestock producers are under increasing regulation to manage animal manure applied to pasture while row crop agriculture in Arkansas is facing dwindling groundwater supplies. Large-scale modeling studies of the Mississippi River basin point to agriculture as the leading source of excessive nutrients that cause hypoxia in the Gulf of Mexico. The State Assembly commissioned ANRC to update the State Water Plan while the Gulf of Mexico Hypoxia Task Force, consisting of 5 federal agencies and 13 states, held their Annual Spring Meeting in Little Rock in May 2014. Others sectors of society such as municipalities and urban areas also face nonpoint source water including municipalities and urban areas are required to address storm water management issues and provide education on reducing the impact of storm water on runoff water quality. Municipalities in 3 Counties have contracted with Extension to provide the Storm water education, providing research-based and unbiased information to Arkansans to assist with voluntary efforts to address nonpoint source water quality issues. In 2014, the State of Arkansas developed a process to update the State Water plan, a comprehensive plan for addressing both water quantity and quality concerns. Further, Arkansas hosted the Gulf of Mexico Hypoxia Task Force meeting in Little Rock.
The University of Arkansas Division of Agriculture delivered the following educational programs:
Arkansas Discovery Farms are real, working farms that allow the monitoring and documentation of water resource parameters related to environmental issues including: 1) edge-of-field monitoring of runoff quality and quantity, 2) irrigation water use, soil health and 3) other selected indicators of environmental impact on natural resources. Discovery Farms is a long-term monitoring, demonstration and educational effort that

works with producers to implement conservation practices and monitor their impact. Currently, we have 9 Discovery Farms representing the major livestock and row crop production systems.
We continue to provide state certification training to nutrient applicators and nutrient management planners. This year we conducted three continuing ed. sessions for certified nutrient management planners and two for nutrient applicators. We also provide education to livestock producers on the value and how to best implement nutrient management plans.
We work very closely with the Arkansas Conservation Partnership to promote voluntary conservation programs through educational efforts such as the distribution of an e-mail newsletter, Conservation Corner (> 2000 Subscribers) and the water sustainability website for clientele in Arkansas. Additionally, we jointly produce a regional newsletter entitled Confluence (> 2000 subscribers) to provide information to the agricultural public on nutrient reduction and water quality protection efforts within the 13 states participating in the Gulf of Mexico Hypoxia Task Force . We also have developed a regional website to provide conservation information across these 13 states.
We received a grant ($189,000) from EPA via ANRC to develop the Arkansas Watershed Steward program, a training program to educate citizens who want to be involved in addressing local water quality concerns. Products that have come out of this project are a 158 page publication, The Arkansas Watershed Steward Program and materials for use in a one-day workshop format. We conducted 8 one-day workshops in the NPS priority watersheds.
Storm water Management- Municipalities in three Counties have contracted with Extension to provide their EPA-required education to citizens or their cities.

2. Brief description of the target audience

Youth
Agri Business
Row Crop Agricultural Producers
Consultants
Forest Landowner Groups
Forest Industry
Loggers
Natural Resource Professionals
Landowners
Educators
Agency personnel
Livestock producers
Watershed and other Not-for-profit organizations
General public
Researchers
Policy makers
Research funding personnel and agencies
Renewable liquid transportation fuel producers

3. How was eXtension used?

The eXtension website was used to (1) augment feral hog control programming and (2) respond to public requests for information about nuisance wildlife. The "Dealing with Wildlife" webpage on the UA Cooperative Extension Service website has a significant number of links to eXtension's wildlife damage website.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	63262	32806	4138	525

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

Patent Applications Submitted

Year: 2014

Actual: 1

Patents listed

Methods of Increasing Resistance of Crop Plants to Heat Stress and Selecting Crop Plants with Increased Resistance to Heat Stress. US PCT/US2014/025923. Inventors: Pereira, Andy / Venkategowda, Ramegowda.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	52	89	128

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of educational programs and events held related to Environment, Energy & Climate.

Year	Actual
2014	145

Output #2

Output Measure

- Number of field days related to Environment, Energy & Climate.

Year	Actual
2014	23

Output #3

Output Measure

- Number of educational materials, curricula, newsletters, web-based modules and fact sheets developed, produced and delivered related to Environment, Energy & Climate.

Year	Actual
2014	78

Output #4

Output Measure

- Number of locations for bioenergy crop demonstrations.
  Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Number of research-based, non-refereed publications published related to Environment, Energy & Climate.

Year	Actual
2014	87

Output #6

Output Measure

- Number of research-based scientific presentations at scientific or professional meetings related to Environment, Energy & Climate.

Year	Actual
2014	112

Output #7

Output Measure

- Number of research projects on biomass crops conducted in Arkansas.

Year	Actual
2014	1

Output #8

Output Measure

- Number of research projects on biofuels performance and emissions conducted in Arkansas.

Year	Actual

2014	1

Output #9

Output Measure

- Funded research amounts (in dollars) related to Environment, Energy & Climate.

Year	Actual
2014	1327000

Output #10

Output Measure

- Number of current year Environment, Energy & Climate relevant research programs.

Year	Actual
2014	19

Output #11

Output Measure

- Number of current year Environment, Energy & Climate relevant educational programs.

Year	Actual
2014	95

Output #12

Output Measure

- Number of clientele who attended educational programs.

Year	Actual
2014	1519

Output #13

Output Measure

- Number of clientele who received educational material.

Year	Actual
2014	1482

Output #14

Output Measure

- Number of on-site, farm visits or one-on-one consultations

Year	Actual
2014	38

Output #15

Output Measure

- Number of educational programs, workshops, educational meetings or field days

Year	Actual
2014	52

Output #16

Output Measure

- Number of on-farm/on-site demonstrations and applied research trials

Year	Actual
2014	7

Output #17

Output Measure

- Number of demonstrations of new wildlife foodplot concept

Year	Actual
2014	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of individuals adopting one practice from the recommended list of energy conserving practices.
2	Number of energy audits conducted.
3	Number of graduate students working on bioenergy projects or biofuels labs.
4	Life cycle inventory methodology and data for row crops for greenhouse gases.
5	Number of N-StaR samples processed.
6	Number of new assessment and management tools developed, including models and measurements of greenhouse gas emmisions
7	Number of current year citations of climate related publications.
8	Number of program participants who indicate a change in behavior, based on lessons learned during Environment, Energy & Climate programs.
9	Number of participants (both youth and adult) indicating new knowledge gained as a result of Environment, Energy & Climate programs.
10	Number of program participants indicating new knowledge of water quality and conservation best management practices
11	Number of producers who changed or adopted new production and/or conservation management practices or technologies
12	Number of program participants indicating the adoption or implementation of new water quality and conservation best management practices.
13	Number of clientele reporting increased knowledge of best water quality and nutrient management practices
14	Number of clientele who increased knowledge of best water conservation practices
15	Number of acres where best water conservation practices used
16	Number of acres where best water quality and nutrient management practices used
17	Number of clientele reporting increased knowledge of best storm water quality and management practices

18	Number reporting increased knowledge of woodlands management
19	Number of validations of Soil Test recommendations on-farm/on-site
20	Number of clients who increased knowledge of best poultry housing indoor air quality practices
21	Number of studies on new soil amendments for improved plant growth
22	Number of research studies on methane gas emissions from rice
23	Number of clientele increasing knowledge of new wildlife foodplot concept

Outcome #1

1. Outcome Measures

Number of individuals adopting one practice from the recommended list of energy conserving practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

Number of energy audits conducted.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Number of graduate students working on bioenergy projects or biofuels labs.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Use of conventional fossil fuels is problematic because of uncertain future supplies, uncertain costs of these fuels, concentration of major fuel supplies in parts of the world which are politically unstable, and the cumulative effects of the release of carbon from the consumption of these resources. Biomass represents a renewable fuel source that can be harvested annually from available solar energy with minimal net carbon release. Algae growth can potentially capture many times more energy (per year per acre) than any other energy crop. Algae can also utilize nutrients from wastewater or from natural waters containing excess nutrients. Algae growth provides biological treatment and water quality improvement of the influent flow. Hence, algae production represents a potentially sustainable energy source.

What has been done
Biological and Agricultural Engineers are investigating systems to produce algae using wastewater from swine production to yield biomass feedstock for biofuel production. The system grows attached periphytic algae in an open flow-way with a continual stream of the inlet swine effluent. Experiments conducted at the UA Swine Grower Unit,Savoy Arkansas used undiluted swine effluent at varied flow rates and surging modes in an attempt to identify optimal growth conditions.

Results
The algae flow way at Savoy is a premier algae research facility to test inland, freshwater periphytic algal productivity at mid-latitudes. The technology employed is scalable to larger areas that would be needed to produce enough biomass to feed large-scale biofuel refineries. The research will quantify the productivity of the systems and fine-tune production strategies. Research results will provide data needed to perform objective economic analyses of the life cycle costs and environmental impacts of the proposed technology.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
511	New and Improved Non-Food Products and Processes

Outcome #4

1. Outcome Measures

Life cycle inventory methodology and data for row crops for greenhouse gases.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management

Outcome #5

1. Outcome Measures

Number of N-StaR samples processed.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	4500

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Arkansas rice producers have relied on soil test recommendations for applying Nitrogen to the crop which are based on response curves from limited test sites. Scientists have been seeking a site specific-test for making N recommendations in rice. N-StaR is a unique, field specific test which identifies the available N from soil samples submitted to the University of Arkansas N-STaR Soil Testing Lab. Recommendations from N-STaR may reduce N rate recommendations significantly without sacrificing yield, thus saving money and potentially reducing N losses to the environment.

What has been done

The Division of Agriculture's soil fertility team were the first to identify a novel method of soil testing and analysis to customize N recommendations on silt loam soils of Arkansas. A series of laboratory experiments and field trials led to the development of N-STaR (Nitrogen-Soil Test for Rice), a field-specific soil N test for rice in Arkansas. N-STaR is a soil-based N test that quantifies the N that will become available to rice during the growing season. Using a steam distillation procedure and analyzing an 18? deep soil sample (in contrast with a typical 4? sample), researchers were able to accurately predict the N needs of rice produced on silt loam soils 89% of the time. N-STaR samples submitted by rice growers ensure proper N recommendations to achieve optimum rice yields on a field-specific basis. N-STaR recommendations should optimize rice yields on all fields, but yields can be increased substantially where native soil N is very high or very low. N-STaR has been available for rice produced on silt loam soils in Arkansas for the 2012 rice crop. N-STaR for clayey soils was on a limited release in 2014 and is now available for all soils in Arkansas.

Results

N-STaR has been adopted quickly by Arkansas rice producers. In 2012, 2500 N-STaR samples were submitted for analysis. The number of N-STaR samples has increased to 3300 in 2013 and 4500 in 2014, but each year these samples are coming from new areas which significantly increases the scope of N-STaR?s impact on Arkansas rice production. ?More than half of the N-STaR recommendations have called for reduced N rates, making the program an economic and environmentally sustainable practice,? says Roberts.

The success of N-STaR technology in rice has led researchers to explore similar programs targeting wheat and corn in Arkansas.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships

Outcome #6

1. Outcome Measures

Number of new assessment and management tools developed, including models and measurements of greenhouse gas emmisions

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Number of current year citations of climate related publications.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	17

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sustainable energy developed by biochemical deconstruction of feedstocks into sugars, then fermented to biobased fuels or chemicals, requires pretreatment of biomass prior to enzymatic hydrolysis. Two approaches are: 1) plant secondary metabolites are extracted prior to pretreatment and tested for antimicrobial and antioxidant properties. In addition of providing a value-added slipstream, the extraction of secondarymetabolites could decrease the toxicity of pretreatment hydrolyzates, and 2) biomass pretreatment, specifically, determining which of the pretreated-generated compound(s) inhibit enzymatichydrolysis. These inhibitory compounds include, but are not limited to, furfural, acetic acid and formic acid, and lignin-derived phenolic compounds, and oligomers. The listed inhibitory compounds inhibit the sugar release step, which, in turn, impedes the conversion of biomass into biofuels or other biobased products. Understanding how to release the sugars from biomass, without producing the plethora of inhibitory compounds, is critical for maximizing biofuel and biobased production yields.

What has been done
Sweetgum and loblolly pine have been tested for inhibitory activity of food safety related microorganisms and inhibition of low density lipoprotein oxidation. Our long-term goal is to develop extraction procedures that enable the production of value-added slipstreams. In terms of pretreatment hydrolyzate characterization, our group is studying herbaceous (switchgrass), agricultural residue (rice straw), and wood (poplar, pine and sweetgum) biomass. We pretreat in dilute acid or hot water and enzymatically hydrolyze the biomass, calculate the sugar recovery, and track the release of inhibitory compounds. We are determining the effect of these inhibitory compounds on the enzymatic hydrolysis system, namely, endo-cellulase, exo-cellulase and β-glucosidase. Our long-term goal is to determine which compounds are key players in causing inhibition to the enzymatic system, and through pretreatment processing conditions minimize their release.

Results

The payoff is quite important in the sense, that the creation of value-added slip streams, the increase of sugar release and decrease of inhibitory compound concentration(s) will set the stage for better use of our biomass resources. In other words, more biobased fuels or chemicals will be produced from a said amount of feedstock.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources
204	Plant Product Quality and Utility (Preharvest)
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #8

1. Outcome Measures

Number of program participants who indicate a change in behavior, based on lessons learned during Environment, Energy & Climate programs.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	624

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Division of Agriculture scientists received funds from Arkansas Governor Mike Beebe to conduct an in-depth case-study of a newly permitted hog farm in the Buffalo National River watershed.

What has been done
A multidisciplinary team is assessing the impacts of the operation of the C&H Farm at Mt. Judea, Newton County, on sustainable on-farm nutrient management, Big Creek, and Buffalo Rivers. The research project is evaluating the sustainable management of nutrients from the C&H Farm operation.
The study includes the following major tasks:

a.Monitor the fate and transport of nutrients and bacteria from land-applied swine effluent to pastures.
b.Assess the impact of farming operations (effluent holding ponds and land-application of effluent) on the quality of critical water features on and surrounding the farm including springs, ephemeral streams, creeks and ground water.
c.Determine the effectiveness and sustainability of alternative manure management techniques including solid separation that may enhance transport and export of nutrients out of the watershed.

Results
A total of 455 water, 460 soil, 62 manure slurry, and 25 forage samples have been collected and analyzed for a suite of constituents by the Big Creek Project since its inception in September, 2013. Despite the large number of samples collected and analyzed, a longer monitoring period is needed to reliably determine if operation of the C&H Farm is or is not having an impact on Big Creek water quality. Scientific consensus suggests that a minimum of five years of monitoring is needed.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management

Outcome #9

1. Outcome Measures

Number of participants (both youth and adult) indicating new knowledge gained as a result of Environment, Energy & Climate programs.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1441

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Under State legislation passed in 1999, all individuals referring to themselves as foresters and providing assistance to private forest landowners must be registered with the AR State Board of Registered Foresters. Statewide, there are approximately 490 registered foresters. Each must complete eight hours of continuing education a year to remain registered.

What has been done
The Arkansas Forest Resources Center Registered Forester Education program works to fulfill these educational requirements of foresters in particular and all other professionals in general. The program also delivers education to other professionals including attorneys, accountants, natural resource managers, county agents, landowners and other Extension professionals.

Each year UA State and county faculty members, working with the AR State Board of Registration for Foresters and the Society of American Foresters, coordinate several conferences targeting the continuing education needs of registered foresters. In FY2014, 3 Registered Foresters Workshops were held and attended by 420 registered foresters from Arkansas and surrounding States and reached more than 90% of all foresters registered with the AR State Board of Registration for Foresters. The number of forest acres managed by these foresters was reported to be over 180,932 acres.

Results
Although the specific topics in each of the three conferences varied, on-site surveys indicate that 65% or 273 participants gained new knowledge as a result of attending the conference.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
204	Plant Product Quality and Utility (Preharvest)
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #10

1. Outcome Measures

Number of program participants indicating new knowledge of water quality and conservation best management practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	651

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
511	New and Improved Non-Food Products and Processes

Outcome #11

1. Outcome Measures

Number of producers who changed or adopted new production and/or conservation management practices or technologies

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop residue burning is an inexpensive and effective method to remove excess residues to control weeds and pests, facilitate planting and sometimes double crop in the southern region of the United States, including the state of Arkansas. However, it contributes to emissions of air pollutants, for example, particulates, carbon monoxide and others, impacting air quality and public health. Since no permit is required to conduct field burning in Arkansas, neither the magnitude of residue burning as a crop residue management method, nor the contribution to air quality is fully understood.

What has been done
This study aims to derive emissions using remote sensing-based techniques to quantify burned area and active fire activities with high temporal resolution in the state. A variety of available satellite-based products have been compared. The crop-specific emissions will be calculated using the high resolution crop data layer maps from USDA. Meanwhile, a state-wide producer survey is on-going to reveal the current crop residue management practices and reasons of the practices. With sufficient sample size, the survey results can potentially be compared with results from remote sensing-based method.

Results
Results of this research will contribute to the temporal and spatial estimation of emissions associated with crop residue burning. A development of the emission estimation will allow air quality modeling research to reveal the relative contribution of residue burning to air quality and potential improvement of any emission reductions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships

112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #12

1. Outcome Measures

Number of program participants indicating the adoption or implementation of new water quality and conservation best management practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The State of Arkansas adopted effects-based water quality standards in 2012 to protect Beaver Lake from accelerated eutrophication. The standards state that the growing season geometric mean chlorophyll-a (chl-a) concentration shall not be greater than 8 µg/L and that the annual average secchi transparency (ST) shall not be less than 1.1 m in Beaver Lake near Hickory Creek. These standards were adopted based on the recommendation of a working group that used a weight of evidence approach to derive the standard recommendations. However, an important missing component of the standard development process, and the adopted numeric standards, was the frequency and duration at which these standards must be met in Beaver Lake at Hickory Creek.

What has been done
In collaboration with Dr. Thad Scott of the University of Arkansas System Division of Agriculture, we developed a single recommendation and list of separate considerations that could be used by the State of Arkansas in developing an assessment plan for the eutrophication standards in Beaver Lake. We utilized the methodology from the original standard development to re-create

their analysis and quantify the risk of exceeding the water quality standards in Beaver Lake at Hickory Creek. The final report outlined this specific recommendation and other considerations in detail.

Results
The Beaver Watershed Alliance, who funded the study, forwarded our final report to the Arkansas Department of Environmental Quality (ADEQ). ADEQ is considering our recommendation in the development of the official state assessment methodology for the eutrophication standards on Beaver Lake and will be proposing this to the US Environmental Protection Agency for final approval.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

Number of clientele reporting increased knowledge of best water quality and nutrient management practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	469

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

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 #14

1. Outcome Measures

Number of clientele who increased knowledge of best water conservation practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	182

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

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

Outcome #15

1. Outcome Measures

Number of acres where best water conservation practices used

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	752

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

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

Outcome #16

1. Outcome Measures

Number of acres where best water quality and nutrient management practices used

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	700

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

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 #17

1. Outcome Measures

Number of clientele reporting increased knowledge of best storm water quality and management practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	965

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

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 #18

1. Outcome Measures

Number reporting increased knowledge of woodlands management

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	52

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The number of farms, ranches, and forest lands managed by women has increased dramatically

over the past few decades. Many of the women owning woodlands are unfamiliar with good forest management practices and the marketing strategies.

What has been done
The UA Arkansas Forest Resources developed a Women Owning Woodlands Program beginning in 2009. During FY14, 32 forest landowners including 25 women, attended a workshop and woodland tour held in March 2014. Landowners participated in a workshop led by Landowner Legacy Communication, a family operated education organization, during which they learned how to develop a communications plan, identify topics and strategies important to successful intergenerational planning, and the basics of a land transfer plan.

Results
Evaluation results suggest that participants' understanding of the need to family meetings related to asset transfers increased by 41%; the understanding of the importance of ground rules in family meetings increased by 38%, and recognition of the importance of family communication increased by 42%. Participants also toured a family forest with the tour during which they learned about the importance of forest management planning, prescribed fire, and hunting leases. Several couples including mothers and daughters attended the one-day workshop. A daughter who brought her mother with her to the workshop, wrote that her mother developed a better understanding of forest stewardship and the necessity of planning, both for the forest and for intergenerational land transfer, as a result of attending the workshop.

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
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #19

1. Outcome Measures

Number of validations of Soil Test recommendations on-farm/on-site

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	16

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil samples are collected by farmers and consultants, submitted to a soil-test laboratory for analysis and the report along with fertilizer recommendations is sent back to the client. Soil chemical analyses have been used as the basis for phosphorus (P), potassium (K) and micronutrient recommendations for nearly 100 years and this process represents the best possible science and technology for estimating fertilizer needs to ensure crop nutrient requirements are met. Unfortunately, the accuracy of interpretation of soil analyses and eventually the fertilizer recommendations have seldom been validated.

What has been done
Our ongoing research sought to validate the accuracy of existing P and K fertilizer recommendations for irrigated soybean. Sixteen field trials were established in 2013 and 2014 and six composite soil samples were collected from each site to determine the recommended P and K rates. Each trial contained six P and K fertilizer treatments which included a no P or K treatment, the recommended rates of P and K rates, and alternate combinations of P and K to examine the accuracy of the rate calibration.

Results
The trial yield results showed that existing fertilizer recommendations based on soil-test P and K accurately predicted crop response to P fertilization in 75% and 78% of the trials when significance was interpreted as significant at the 0.10 level and results were weighted across soil-test categories (e.g., suboptimal, medium and optimal or greater fertility). The accuracy of the implemented K recommendations improved to 84% when the level of significance was reduced to 0.25, but did not change for P. For both nutrients, the accuracy of the recommendations varied among the three fertility categories. Accuracy was lowest (25-33% at the 0.10 significance level) for soils that had suboptimal fertility levels indicating that the soil-test values that define the existing fertility levels need to be redefined to improve accuracy

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
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation

Outcome #20

1. Outcome Measures

Number of clients who increased knowledge of best poultry housing indoor air quality practices

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	100

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
141	Air Resource Protection and Management

Outcome #21

1. Outcome Measures

Number of studies on new soil amendments for improved plant growth

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Biochar has the potential to turn waste products generated in important agricultural sectors in Arkansas (e.g. poultry litter and pine wood waste) into beneficial soil amendments. Biochar, the charcoal product of anaerobic thermal decomposition of biomass, has shown promise as a soil amendment in tropical soils, but results of biochar research on crop growth and nutrient availability have varied in temperate zone soils. Feedstock used to produce biochar, biochar production conditions and final product characteristics, rates of biochar application, and soils have all varied across research studies, adding to the confusion about how biochar impacts the agroecosystem. For producers to benefit from biochar amendments to soil, there needs to be better understanding of when and how biochar can be beneficial.

What has been done
Laboratory, greenhouse, and field experiments were conducted to investigate potential mechanisms for biochar impacts on plant growth and crop production and soil properties. A laboratory experiment investigated the relationship between soil water potential and water content across a wide range of moisture conditions with one of two types of biochar (poultry litter or pine wood) mixed into soil at rates equal to 0, 5, and 10 Mg ha-1. A greenhouse experiment investigated mycorrhizal infection, soil nutrient availability, and corn (Zea mays L.) growth in the presence of poultry litter biochar (0, 5, and 10 Mg ha-1) and nitrogen (N) and phosphorus (P) fertilizer (0, half, and full rates). A field experiment focused on soil biological and chemical properties and corn yield under field conditions in the first growing season after biochar addition (0, 5, and 10 Mg ha-1) and nitrogen (N) fertilization (0, half, and full rates).

Results
In both the greenhouse and field experiments, biochar improved plant characteristics. In the greenhouse, there was a more extensive root system and greater aboveground biomass with the highest rate of biochar used in the study (10 Mg ha-1). In the field, the greatest yield (when combined with fertilizer) and the greatest nitrogen use efficiency occurred with the highest biochar rate (10 Mg ha-1). There were few effects on microbial and soil nutrient properties. While analysis of the laboratory data indicated that the poultry litter biochar had greater water retention capacity across a wide range of water potentials than the pine wood biochar, water retention capacity was unaffected by application rate. Furthermore, results indicated biochar may not generally improve water retention at all water contents with one-time application rates. Taken together, results illustrate that mechanisms allowing biochar to provide agronomic benefit still need further investigation. However, these initial results suggest that biochar has, at the proper rate and in combination with fertilizer, the potential to improve agronomic performance in the midsouthern U.S.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #22

1. Outcome Measures

Number of research studies on methane gas emissions from rice

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Methane (CH4) is one of the major greenhouse gases and has a global warming potential many times greater than carbon dioxide. Methane production occurs under anaerobic soil conditions, such as those associated with rice production. Due to the anaerobic conditions that develop in soils used for flooded rice production, along with the global extent of rice production, some sources believe that rice cultivation contributes to global anthropogenic CH4 emissions. The current U.S. estimates of CH4 emissions from rice are based on data from all of the major rice-growing regions, however, there is a general lack of data representing Arkansas cultural practices and a lack of data from studies conducted in Arkansas specifically.

What has been done
Field studies were conducted in 2012 and 2013 at the Northeast Research and Extension Center in Keiser on a Sharkey clay to quantify season-long methane emissions from conventional and hybrid rice varieties grown following rice or following soybean. A chamber-based gas sampling procedure was used to directly quantify methane fluxes on a weekly basis over the growing season from flooding to after harvest.

Results
Season-long methane emissions are generally substantially lower clay soils than from silt-loam soils, lower from hybrid than from conventional, pure-line cultivars, and lower from rice following soybean than rice following rice. The low emissions measured, coupled with the magnitude of Arkansas rice production and extent of production on clay to clay loam soils in Arkansas, indicates that CH4 emissions from mid-southern U.S. rice cultivation may be substantially overestimated and the reported emissions factor used by the Environmental Protection Agency likely needs to be revised to account for more known factors that affect methane emissions from rice production (i.e., soil texture, cultivar, and previous crop).

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation

Outcome #23

1. Outcome Measures

Number of clientele increasing knowledge of new wildlife foodplot concept

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In Arkansas and the southeastern U.S., hunters spend significant time and money planting food plots for harvesting deer. An alternative is native food plots amended with boiler ash, a byproduct of timber mills.

What has been done
Demonstrations of native food plots and boiler ash applications were viewed at a county agriculture agent in-service training and landowner field days at the Southwest Research and

Extension Center. The concept has also been presented (a) statewide in landowner meetings and other in-service trainings, (b) regionally at the Missouri Natural Resources Conference, and (c) nationally in the Journal of the National Association of County Agriculture Agents.

Results
Although native food plots are gaining traction nationally, changing the cultural norm will be difficult to overcome. For example, a landowner from Scott County spoke positively of native vegetation and prescribed burning, yet even he plants a traditional food plot near his deer stand.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources
204	Plant Product Quality and Utility (Preharvest)
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

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

The outlook for forestry and forest products, at least in the short term, does not provide incentive for Arkansas forest landowners to make substantial investments in improvements of forest land. In Arkansas, where very little infrastructure related to biofuels has evolved, there is little incentive for producers of biofuels feedstocks to invest in alternative biofuels crops and related equipment. Interest in growing alternative biofuel crops in the state today is low, where traditional row crops enjoy reasonable profitability and the short term outlook for oil prices does not favor investment in biofuel alternatives.
The Big Creek research effort led by the Division's team of water resource protection scientists is authorized to continue monitoring water quality, including nutrients and bacterial concentrations, in a sensitive watershed, but the state funding for this long-term effort is uncertain.
The emergence of a viable and dynamic Carbon Market could have a big impact among Arkansas forestland and cropland managers.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The Center for Agricultural and Rural Sustainability (CARS) completed a $3 million National Sustainable Strawberry Initiative, funded by the Wal Mart Foundation, in 2013. CARS faculty monitored the progress of 20 research and extension projects aimed at reducing the environmental impact on US strawberry production while increasing opportunities for production outside the traditional production areas. The projects were conducted July 2013 to June 2014. Project leaders submitted quarterly reports, created project videos, contributed to a program blog and shared information about their research with growers at workshops and field days. Project outputs and outcomes were shared through various media outlets including the program website, blog, Facebook, Twitter, SmugMug, Slideshare and YouTube sites. resulting in over 300,000 consumers, growers, advisors, educators, scientists and students informed by the NSSI project. The Wal Mart Foundation was sufficiently asked CARS to administer a $1 million Phase II of the NSSI in 2014.
The Discovery Farm Program is addressing the Best Practices for sustainable agricultural productionon nine farms in Arkansas. Discovery Farm uses edge-of-field monitoring of both the quantity and quality of inflow and runoff from fields on real, working farms. Data collected quantifies nutrient and sediment losses to determine off-farm environmental impacts and addresses long-term sustainability and profitability. The nine Discovery Farms strategically placed across the State to represent the predominant livestock and row crop enterprises. Discovery Farms showcase stewardship through website, field days, tours and through oral presentations throughout the State at various events. Discovery Farms generate opportunities for education and outreach efforts including: 1) Presentations made to more than 3,000 people at various events in Arkansas, 2) Conducted 15 field tours during the last three years for the Joint House/Senate Agriculture Committee, Arkansas Congressional staffers, Wal-Mart Sustainability Coordinators from eleven nations, Arkansas Farm Bureau, Natural Resources Conservation Service (NRCS), United Soybean Board Sustainability Workgroup, and a Multi-State (Seven States) Discovery Farm Tour.
The N-STaR samples submitted to the University of Arkansas N-STaR Soil Testing Lab during 2013 were categorized by county and soil texture. Samples were received from 27 Arkansas counties. The samples received were from 171 silt loam fields and 137 clay fields. In total the lab analyzed roughly 4,000 soil samples during the 2013 growing season. The N-STaR N rate recommendations for these samples were then compared to the producer's estimated N rate or the standard Arkansas N rate recommendation of 150 lb N/acre for silt loam soils and 180 lb N/acre for clay soils and divided into three categories--those with a decrease in recommendation, no change in recommended N rate, or an increase in the N rate recommendation. Samples classified as silt loams indicated a reduced N rate for 60% of the fields analyzed and the average N rate reduction was 25 lb N/acre, whereas clay soils resulted in reduced N rates for 70% of the fields tested with an average reduction in the N rate of 39 lb N/acre. These results from the 2013 season indicate the potential to reduce N rates for rice produced on both clay and silt loam soils while still maintaining yield and producer profitability. One of the greatest testaments to the N-STaR program came in 2013, when the N-STaR N rate recommendations were used in all of the Rice Research and Verification Program Fields. In the southern portion of Arkansas 8 of the 11 RRVP fields had significantly lower N rates using the N-STaR program than the producer would have traditionally applied based on soil texture, variety and previous crop. For those fields that indicated a reduced N rate the average reduction was 35 lb N/acre, but yields were drastically higher than the state average coming in at 196 bushels/acre. The inclusion of N-

STaR in the RRVP is the first field-scale "real world" test for the program and based on 2013's yield results, it passed with flying colors.
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Key Items of Evaluation

The number of N-StaR samples processed has increased every year since inception, indicating growing demand for the program and broader application of the research. It is unlikely that farmers will go to the inconvenience of taking and submitting N-S-STaR samples without implementing the recommendations.
The number of acres where best water conservation practices used and number of acres where best water quality and nutrient management practices used are both indicators of successful research and Extension impacts. These numbers may only reflect a fraction of the applications, but growing numbers indicates broader application.
The number of on-farm/on-site demonstrations and applied research trials indicates demand for information and willingness to adopt new practices.
Number of on-site, farm visits or one-on-one consultations is and indicator of interest as well as trust-in- source or competence.