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
101	Appraisal of Soil Resources	3%		3%	
102	Soil, Plant, Water, Nutrient Relationships	20%		19%	
111	Conservation and Efficient Use of Water	10%		7%	
112	Watershed Protection and Management	6%		7%	
123	Management and Sustainability of Forest Resources	5%		5%	
124	Urban Forestry	2%		0%	
131	Alternative Uses of Land	2%		2%	
133	Pollution Prevention and Mitigation	3%		2%	
135	Aquatic and Terrestrial Wildlife	2%		1%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		12%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	2%		6%	
204	Plant Product Quality and Utility (Preharvest)	5%		5%	
205	Plant Management Systems	5%		2%	
211	Insects, Mites, and Other Arthropods Affecting Plants	6%		3%	
306	Environmental Stress in Animals	2%		5%	
403	Waste Disposal, Recycling, and Reuse	5%		0%	
405	Drainage and Irrigation Systems and Facilities	5%		4%	
511	New and Improved Non-Food Products and Processes	4%		6%	
605	Natural Resource and Environmental Economics	10%		10%	
610	Domestic Policy Analysis	3%		1%	
	Total	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	17.7	0.0	24.4	0.0
Actual Paid Professional	18.3	0.0	122.7	0.0
Actual Volunteer	2.8	0.0	1.8	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
271468	0	988730	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
349377	0	12988432	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
2523563	0	3515572	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Arkansas has abundant natural resources. Novel water demands, land ownership patterns, regulations, scientific understanding, erasures of environmental sustainability all impact our Natural State. These issues require an ability to adapt, to modify behavior, and to fix the problems of our own making. Whether by rule, incentive or knowledge, we must bring scientific understanding to our daily dollars and cents existence.

Conserving Water Resources

Mounting pressures placed on Arkansas's water resources require conservation of water quantity and quality. Declining groundwater escalates competition among residential, recreational, agricultural, municipal and industrial users. Water quality issues focus attention on identifying and controlling contaminant sources. Science based knowledge is necessary for effective water policy and workable solutions. A clean, ample water supply is essential to Arkansas's future in the competitive global marketplace. Concerns include science based, cost-effective and practical water conservation; better understanding land management trends; conflicting social and economic priorities; conflicting state, local and national regulations; and incentives for improving management and uses of water.

THE U OF A DIVISION OF AGRICULTURE WILL:

- Improve efficient use and conservation of water resources through research and education
- Educate Arkansans about competing demands for water quantity and quality for agricultural, residential, recreational, wildlife, industrial and municipal needs
- Inform decision makers with science based information on water quantity and quality. Collaborate with state and federal agencies to sustain water resources
- Provide the science based information needed to understand changing environmental regulations

Alternative Energy and Conservation

Arkansans are interested in energy conservation and alternative energy sources. Arkansas's strong agricultural base positions us for developing bioenergy production. Developing alternative energy systems will require impact analysis on the environment, communities and agricultural markets. Although farm and residential energy conservation is needed, information on technologies, practices and expertise for increasing energy efficiencies is frequently lacking. The ability of citizens to respond to the changing energy environment requires an educated public capable of making informed decisions.

THE U OF A DIVISION OF AGRICULTURE WILL:

- Develop sustainable and regionally appropriate bioenergy production systems. Evaluate and demonstrate energy efficiency and conservation for agricultural and residential applications
- Provide science based information to guide public understanding of alternative energy sources
- Collaborate with state and federal agencies on assessing alternative energy options and measuring impacts
- Conduct research on the impact of energy based resource extraction on natural ecosystems.

Natural Resource Sustainability

Balancing socioeconomic development with environmental protection is complex. Opportunities exist to address forest and land management, regulatory policies, knowledge about renewable and reusable resources, nuisance and invasive species issues, and conflicts at the rural/urban interface.

THE U OF A DIVISION OF AGRICULTURE WILL:

- Determine the effects of urbanization and changing rural ownership patterns on natural resources
- Develop natural resource management strategies, balancing socioeconomic development and environmental protection
- Provide science based information to reduce negative impacts of invasive species
- Provide consumers information to make educated decisions regarding "green" choices

Climate Change

Extreme climatic events prompt us to understand the science behind them. Better knowledge should enable decision makers to respond to such events and to influence the development of local, state and national policies. The development of cropping systems adapted to environmental extremes, tools for communities to lessen the effect of climatic events (floods, droughts, tornadoes, etc.) and the development of contingency plans for climate variations are essential. Agricultural and forestry production practices will be evaluated for their potential to mitigate greenhouse gas emissions and sequester carbon in soils and vegetation

THE U OF A DIVISION OF AGRICULTURE WILL:

- Help Arkansas's communities and agriculture adapt to climate variations and extreme weather or climate related events
- Analyze and explain local impact of national and international climate policies
- Provide unbiased information about the science behind the climate debate
- Evaluate agricultural production practices to reduce greenhouse gas emissions and sequester carbon

New Technology

Technologies associated with energy, climate and natural resource use are in a constant state of change. The Division of Agriculture will provide a competent venue for studying technologies and their potential as tools in the pursuit of a sustainable future, including renewable energy adaptations, biosensors and cell phone applications. In phone based control of one's in-home amenities, Arkansas's citizens will be provided with a rapidly changing array of technological tools and choices.

THE U OF A DIVISION OF AGRICULTURE WILL:

- Provide a competent venue for studying available technologies and their potential as tools in the pursuit of a sustainable future
- Explore cell phone-based control of in-home amenities
- Explore how Arkansas's citizens will be provided with a rapidly changing array of technological tools and choices.

2. Brief description of the target audience

4-H Club Youth
Business Personnel
Row Crop Agricultural Producer Organizations
Row Crop Agricultural Producers
Certified Crop Advisors
Conservation District Directors
Consultants
Forest Landowner Groups
Forest Industry personnel
Loggers
Natural Resource Professionals
Registered Foresters
Landowners
Homeowners
Educators
State & Federal Agency personnel
Watershed Organizations
Wildlife Organizations
Private nutrient applicators
Commercial nutrient applicators
Livestock and Poultry producers
Livestock and Poultry industry personnel
Livestock and Poultry producer organizations
General public
Researchers
Policy makers
Youth
Teaching faculty
Research funding personnel and agencies

3. How was eXtension used?

As a member of a feral hog Community of Practice with eXtension.org, an Extension faculty member helped develop and market materials regarding the threat of feral hogs to the environment and effective control strategies for feral hogs. A Facebook page about feral hogs was developed to promote the new eXtension website a series of webinars. The webinars were hosted on the website in late fall 2012.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	20427	140399	1625	104

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

Patent Applications Submitted

Year: 2012

Actual: 3

Patents listed

System and Method for Optimizing the Dissolution of a Gas in a Liquid US Utility Patent Application 3/415,402, filed 3/8/2012 Inventor: Scott Osborn

Systems and Methods for Wastewater Treatment. US CIP 3/415,539 filed 3/8/2012. Inventor: Scott Osborn, Marty Matlock

Systems and Methods for Maximizing Dissolved Gas Concentration of a Single Species of Gas from a Mixture of

Multiple Gases. US Provisional 61/543,858. Filed 10/6/2011. Inventor: Scott Osborn

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	10	105	115

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of programs held for professional natural resource managers

Year	Actual
2012	10

Output #2

Output Measure

- Number of Natural Resource Educational Meetings conducted for landowners/public

Year	Actual
2012	72

Output #3

Output Measure

- Number of Natural Resource Field Demonstrations

Year	Actual
2012	15

Output #4

Output Measure

- Number of Natural Resource Field Days

Year	Actual
2012	4

Output #5

Output Measure

- Number of Educational Materials & Curricula developed (fact sheets, presentations, handouts)

Year	Actual
2012	130

Output #6

Output Measure

- Number of Natural Resource Newsletters developed

Year	Actual
2012	4

Output #7

Output Measure

- Number of web-based modules, sites developed and/or maintained

Year	Actual
2012	4

Output #8

Output Measure

- Number of Educational Materials & Curricula delivered

Year	Actual

2012	4226

Output #9

Output Measure

- Number of Natural Resource Newsletters delivered
  Not reporting on this Output for this Annual Report

Output #10

Output Measure

- Number of individuals attending manure management related presentations addressing environmental issues

Year	Actual
2012	550

Output #11

Output Measure

- Number of individuals engaged in manure management related consultations addressing environmental issues.

Year	Actual
2012	50

Output #12

Output Measure

- Number of hits at manure management Web page addressing environmental issues.
  Not reporting on this Output for this Annual Report

Output #13

Output Measure

- Number of educational meetings related to air quality/emissions.
  Not reporting on this Output for this Annual Report

Output #14

Output Measure

- Climate Change: Funded Climate Change research amounts (in dollars).

Year	Actual
2012	1029750

Output #15

Output Measure

- Sustainable Energy: Number of educational programs and events held related to sustainable energy.

Year	Actual
2012	32

Output #16

Output Measure

- Sustainable Energy: Number of field days related to sustainable energy.

Year	Actual
2012	0

Output #17

Output Measure

- Sustainable Energy: Number of educational materials & curriculum developed.

Year	Actual
2012	2

Output #18

Output Measure

- Sustainable Energy: Number of locations for bioenergy crop demonstrations and research fields.

Year	Actual
2012	4

Output #19

Output Measure

- Sustainable Energy:Funded Research amounts (in dollars)

Year	Actual
2012	750483

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of participants indicating an increased knowledge of forestry and wildlife management
2	Number of participants who adopt forestry and wildlife management practices as self reported.
3	Number of participants indicating an increased knowledge of air quality/emissions
4	Number of participants indicating an increased knowledge of water quality/quantity
5	Number of participants who adopt water quality/quantity practices
6	Number of registered foresters maintaining certification
7	Number of nutrient management planners and applicators maintaining state certification
8	Number of livestock production clientele who gained knowledge related to manure management issues.
9	Number of clientele who implemented improvements in their manure management practices.
10	Number of participants adopting at least one best management practice related to stormwater.
11	Climate Change: Number of metrics developed for greenhouse gas emissions in agriculture.
12	Climate Change: Life cycle inventory methodology and data for row crops for greenhouse gases.
13	Sustainable Energy: Individuals adopting one practice from the recommended list of energy conserving practices.
14	Sustainable Energy: Number of energy audits conducted.
15	Sustainable Energy: # of livestock clientele who gained knowledge related to manure to energy issues.
16	Number of Research Projects to determine effects of Climate Change on Agricultural Production
17	Number of Research Projects to determine biomass inventory and analysis in forests.

18	Number of soil samples submitted for customized recommendations in the N-StaR program

Outcome #1

1. Outcome Measures

Number of participants indicating an increased knowledge of forestry and wildlife management

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2436

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Invasive plants and animals such as fire ants, feral hogs,kudzu, Paulownia, Japanese honeysuckle, and privet already have become entrenched in Arkansas' forests. We have no reliable estimate describing the economic losses resulting from these invasive species in Arkansas. We also know that several potential invasive pests could reach Arkansas at any time.

What has been done
Extension collaborated with the Arkansas State Plant Board and USDA Plant Health Inspection Service (APHIS) to develop an outreach program providing information and training regarding new invasive species in Arkansas' forests. In 2012, the program launched a website on invasive pests focusing on six forest invasive pests that had not been identified in Arkansas. Collectively, these invasive pests have the potential to cause tens of millions of dollars damage to Arkansas forests. The web site also includes information on species currently in Arkansas. The website went "live" in September 2012. Faculty members presented information about our program in general and invasive species in particular at several workshops and meetings including Continuing Education workshops for Registered Foresters, Master Gardeners, Arkansas State Park personnel, and the regional Society of American Foresters meeting.

Results
Outreach efforts directly reached over 500 participants. Surveys conducted on-site suggest that we?ve helped increased people's understanding of the problems associated with invasive pests. One Master Gardener wrote, "Because of two presentations of yours that I heard, I removed five 15-year-old burning bushes as well as a 15-year-old wee clump of Japanese Blood grass. I

decided I could not advocate planting natives and removing invasive species when our yard displayed beautiful specimens of plants that are causing environmental problems. People drive by my gardens to get ideas about what to plant; they stop and ask questions too. Rather difficult for me to say, 'Don't plant these' when they are on display in our yard. Just wanted you to know that you are making a difference with your talks".

Funding for the program was received from the Arkansas State Plant Board. Program implementation will continue into 2013. An on-line course will be released in Spring 2013 for county agents. It will also be made available to registered foresters and other interested individuals in late Spring 2013.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
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
124	Urban Forestry
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
605	Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

Number of participants who adopt forestry and wildlife management practices as self reported.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	762

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
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
124	Urban Forestry
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
605	Natural Resource and Environmental Economics

Outcome #3

1. Outcome Measures

Number of participants indicating an increased knowledge of air quality/emissions

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of participants indicating an increased knowledge of water quality/quantity

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
While wastewater treatment plants (WWTP) employ disinfection protocols which greatly reduce microbial numbers, WWTPs are not designed or required to completely remove diffuse organic pollutants such as genetic elements. Some of the genes that pass through WWTPs and enter receiving streams carry traits such as antibiotic resistance which can affect health and ecology from humans to agriculture to the functioning of ecosystems.

What has been done
We investigated dissolved ozone as a means for the destruction of broad-host-range (BHR) plasmids, which can spread among unrelated organisms, and chromosomal DNA, under controlled conditions and in pilot-scale tests using an experimental unit in a municipal WWTP. We compared results with ultraviolet (UV) irradiation and chlorination methodologies. We used culture based and molecular methods to assess destruction of bacteria and specific genes.

Results
None of the disinfection methods completely destroyed BHR plasmids or chromosomal DNA, indicating high concentrations of dissolved ozone or other disinfection strategies may be necessary to ensure complete destruction of BHR plasmid DNA in WWTP effluent. Mobile genetic elements such as BHR plasmids can be considered emerging contaminants. The lack of congruency between methodological approaches highlights the need to calibrate molecular methods with more traditional culture-based methods for quantification of fecal indicator bacteria and genetic elements such as BHR plasmids.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Number of participants who adopt water quality/quantity practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agriculture in Arkansas is under pressure to manage nutrients and sediment in an environmentally sustainable manner. This has created constraints to remaining competitive in today's global market place. Increasing national attention is being focused on reducing nutrients to the Gulf of Mexico, which will increase the need for nutrient efficiency while declining groundwater levels in crop producing areas of eastern Arkansas will increase the need for greater water efficiency.

What has been done
In 2012, the Division's Discovery Farm program expanded to include a Cotton Discovery Farm, a row crop farm and we received funding from the Walton Family Foundation to establish a Poultry Livestock Farm. We are monitoring runoff quality from seven farms at six locations as we are quantifying sediment and nutrient losses from all major row crop and livestock commodities including rice, soybean, corn, cotton, poultry and cattle. We are monitoring the quality of runoff from 19 fields using automated water quality samplers, equipped modems that contact us via cell phone when sampling is initiated. On row crop fields, we have increased efforts to monitor water use and needs. All fields are equipped with irrigation flow meters that use dataloggers to record flow data. On two farms, we split fields in half and monitored evapotranspiration with atmometers (ET gages) and compared to our computer irrigation scheduler to calibrate the ET gages as an easier field method for irrigation scheduling.

Results
Over $1.5 million dollars from 15 different funding sources has been raised in support of the Arkansas Discovery Farm program, leveraging nearly $1 million from a Conservation Innovation Grant from NRCS. Ownership has been transferred to a Stakeholder Advisory Committee.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
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 of registered foresters maintaining certification

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	491

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
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
124	Urban Forestry
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
605	Natural Resource and Environmental Economics

Outcome #7

1. Outcome Measures

Number of nutrient management planners and applicators maintaining state certification

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

Outcome #8

1. Outcome Measures

Number of livestock production clientele who gained knowledge related to manure management issues.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Management of animal manure is a critical issue for livestock producers, poultry producers, the poultry industry and the general public. Research has provided evidence of the effectiveness of best management practices (BMPs) in reducing the impact of animal agriculture on water quality. However, an economic evaluation of producers' options when implementing BMPs is scarce. Consequently, this research was designed to economically and environmentally evaluate a range of management alternatives under uncertain production conditions using stochastic dominance with respect to a function (SDRF).

What has been done
We compared 59 different BMPs in terms of net returns risk reduction for hay producers, emphasizing cost-effective practices to reduce total phosphorous (TP) runoff while maintaining profitability. To assess the value of BMPs to reduce TP runoff, SDRF was employed to analyze scenarios covering hydrologic, economic and risk analysis components of a hay production farming system. The hydrologic model was run to generate TP loading and bermudagrass yield data for each scenario. Bermudagrass yield data sets were inputs to the economic model. Yield data were utilized to calculate net returns for each scenario analyzed. Outcomes from the hydrologic and economic models were input to the risk model. This last model was employed to evaluate the impact of decision-makers? risk attitudes on BMP scenario preferences under both net returns and TP runoff reductions.

Results
This simulation provided evidence that TP runoff could be reduced without affecting producers' expected net returns when environmentally efficient and economically acceptable BMPs are implemented. Results showed that decision makers will be reluctant to adopt BMPs that reduce drastically their net returns regardless of their water quality benefits. Consequently, decision

makers should compare net returns risks and environmental benefits of implementing BMPs to reduce TP runoff, so that producers will be able to select BMPs with the lowest negative economic impact in their hay production operations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

Outcome #9

1. Outcome Measures

Number of clientele who implemented improvements in their manure management practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Consumers and retailers have grown more aware of the environmental impact of their purchases and are interested in mitigating those impacts. Concurrently, agricultural industries are working to improve the environmental performance of their operations in a way that is also economically sustainable. Dairy and pork industries for example are currently focusing on the mitigation of greenhouse gas (GHG) production. However in order to improve environmental performance and continue to meet economic objectives, the industry needs to understand the sources of GHG and the costs of mitigation.

What has been done
Researchers have teamed with others to conduct environmental (GHG) life cycle assessments and related life cycle costing studies for agriculture. Across dairy and pork, manure handling practices contribute substantially to on-farm GHG generation. Similarly, feed represents a large variable cost and manure handling technologies represent large capital costs for producers. Experiments are currently under way to 1) to identify changes in dietary strategies that include ingredients with lower carbon footprints or diets that increase feed efficiency and modify manure

handling practices to reduce GHG emissions without generating large increases in costs.

Results
While there is not a one-size-fits-all solution to GHG emissions reduction in the livestock sector, reduction opportunities do exist across the spectrum of farm management options. However, as with all decisions, it is important to weigh potential trade-offs with economic costs and even other environmental impacts (or example the possibility of increased eutrophication under nutrient retention management options) to ensure producers, consumers and retailers can take actions to move towards a fully sustainable agricultural system.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

Outcome #10

1. Outcome Measures

Number of participants adopting at least one best management practice related to stormwater.

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

Climate Change: Number of metrics developed for greenhouse gas emissions in agriculture.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rice ranks highest among cereal crops in global warming potential, largely attributed to methane emissions resulting from growing rice in flooded conditions. There are reported differences in cultivar gas emissions and elevated nitrous oxide emissions resulting from overuse of nitrogen fertilizer. It is important to understand the potential for reducing greenhouse gas emissions in rice production and to capitalize on carbon credit revenues predicted to be in the near future. Rice producers in Arkansas will be in a unique position to capitalize on additional revenues from a carbon market and specialized markets that pay a premium for green rice.

What has been done
Research in collaboration with the University of California at Davis establishing base lines on GHG emissions and evaluating management changes that would reduce GHGs. The impact of nitrogen fertilizer levels on nitrous oxide emissions and possible varietal differences in total greenhouse gas emissions was measured with a static-chamber gas collection system. Variables included flood management and duration and rice variety.

Results
Drill-seeded rice production, as practiced in Arkansas, results in reduced greenhouse gas emissions when compared to a the water-seeded system used in California and much of the world. With proper nitrogen fertilizer management it is possible to reduce nitrous oxide emissions in rice to those similar to a properly managed corn or wheat production system. Over two years we found that nitrous oxide emission differences varied according to variety over a growing season. These results indicate a high potential to reduce global warming potential through variety selection. Results illustrate a potential for rice farmers to capitalize on any benefits related to reducing global warming in rice production by simply making the correct production practice changes needed to maintain production in a reduced irrigation water environment. Nitrogen fertilizer management and developing rice varieties with reduced methane emissions will aid this effort.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
131	Alternative Uses of Land
605	Natural Resource and Environmental Economics

Outcome #12

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Methane (CH4) has GHG potentially 23 times greater than carbon dioxide. Rice, as a semi-aquatic plant, rice is produced under flooded conditions for the majority of the time it is actively growing. Flooding results in soil chemical changes, including methane emissions in soils when the soil is highly anaerobic. Data concerning directly measured methane fluxes from Arkansas, the largest rice-producing state, are lacking.

What has been done
A study conducted in 2012 to investigate CH4 emissions from Arkansas rice production practices, evaluating the effects of previous crop (i.e., rice and soybean) and variety (i.e., conventional and hybrid rice) on season-long methane emissions on silt loam. Similarly, research was conducted on a Sharkey clay to evaluate season-long methane emissions from a conventional rice variety. A chamber-based gas sampling procedure was used to quantify methane fluxes over the growing season from flooding to after harvest.

Results
Preliminary results indicate that methane emissions are greater from rice following rice than from rice following soybean, presumably due to substantial differences in carbon returned to the soil between rice and soybean, and that methane emissions may be lower from hybrid rice than from conventional varieties. Furthermore, it appears that methane emissions in general are significantly lower from clay than from silt-loam soils. Overall, it is clear that soil texture, rice variety, and previous crop are key factors controlling methane emissions from rice.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
131	Alternative Uses of Land
605	Natural Resource and Environmental Economics

Outcome #13

1. **Outcome Measures**

Sustainable Energy: Individuals adopting one practice from the recommended list of energy conserving practices.

Not Reporting on this Outcome Measure

Outcome #14

1. **Outcome Measures**

Sustainable Energy: Number of energy audits conducted.

Not Reporting on this Outcome Measure

Outcome #15

1. **Outcome Measures**

Sustainable Energy: # of livestock clientele who gained knowledge related to manure to energy issues.

Not Reporting on this Outcome Measure

Outcome #16

1. **Outcome Measures**

Number of Research Projects to determine effects of Climate Change on Agricultural Production

2. **Associated Institution Types**

- 1862 Research

3a. **Outcome Type:**

Change in Knowledge Outcome Measure

3b. **Quantitative Outcome**

Year	Actual
2012	1

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

Issue (Who cares and Why)
Mid-south rice comprises approximately 80% of U.S. rice production. Increasing variations in milling quality and other quality parameters in Mid-south rice have been largely unexplained. A hypothesis that elevated ambient temperatures were a culprit for this variation needs to be tested to ensure that proper solutions to quality challenges are pursued.

What has been done
Experiments conducted in growth chambers and phytotrons provided evidence that nighttime air temperatures during kernel-formation reduced rice milling yields and physicochemical properties. Also, field studies were conducted to determine if nighttime air temperatures were correlated to rice quality. Six locations were strategically selected in Arkansas during 2007 to 2010. At each location, six cultivars ranging in milling yield stability, were planted in replicated plots. Air temperatures and rice physiological growth stage was measured at each location for each cultivar. Once harvested, a complete set of milling and property measurements were taken.

Results
The study clearly showed that nighttime air temperatures during the kernel-filling stages of development were strongly correlated to visual, milling, and functional properties. While somewhat cultivar specific, as nighttime air temperatures during kernel filling increased, milling yields dramatically decreased. Of the milled rice produced, chalkiness increased dramatically as nighttime air temperatures increased above approximately 25oC. Proximate properties such as amylose content and crude protein content decreased linearly, while total lipid content increased linearly. These property changes in turn impacted functional properties. Because impacts were cultivar specific provides some promise that genetic improvements can be sought to reduce the impact of high nighttime air temperatures.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #17

1. Outcome Measures

Number of Research Projects to determine biomass inventory and analysis in forests.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In pine forests of the southern United States, pine stems are typically 50-65% of the stems present and Sweetgum represents 10-15% of all stems. The USDA Forest Service database revealed that 83,993,116 oven dry Mg of sweetgum biomass exists in softwood cover types in Arkansas, and is generally a "nuisance" tree. Harvesting understory trees in concurrent operations with pine harvests can generate mixed biomass at delivered prices of $45-55 per oven dry Mg in a radius of 35 miles around a potential bio-refinery. Sorting so that biomass harvests have relatively pure (>95% sweetgum) biomass will add $15-20 per oven dry Mg to the delivered price.

What has been done
Dilute acid pretreatment at 160 C for 20 minutes, followed by enzymatic hydrolysis resulted in a glucose recovery of 65% for a mixture of 70% sweetgum wood and 30% oak wood. This was the highest glucose recovery of all the tested conditions. Hot water sweetgum bark extracts displayed anti-microbial properties, specifically against Listeria monocytogenes.

Results
These results illustrate that it may be possible to obtain co-products from sweetgum bark that could be used in the food industry. Knowing that oak and sweetgum wood can be mixed in dilute acid pretreatment, without affecting saccharification yields, will enable the design of harvesting scenarios that can tolerate hardwood mixtures. Not having to collect pure sweetgum will minimize the footprint of the harvesting operation, simplifying the harvesting operation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
205	Plant Management Systems
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #18

1. Outcome Measures

Number of soil samples submitted for customized recommendations in the N-StaR program

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3800

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Current nitrogen (N)fertilizer recommendations for rice in Arkansas are based on variety, soil texture and yield goal, with little to no account for the soil's ability to supply N to the crop. All soils have the ability to supply N to crops, but some soils due to their parent material, cropping history and intrinsic nutrient supplying capacity can produce the same yield with much lower N fertilizer inputs. Understanding how soils differ in their ability to supply crops with N has been the focal point of soil fertility researchers for years.

What has been done
The University of Arkansas recently developed soil testing procedures to accurately quantify the soil's ability to supply N to growing crops and develop N fertilizer recommendations on a field-specific basis. The Nitrogen Soil Test for Rice, N-STaR, is the first soil-based N test for field specific recommendations. N-STaR quantifies the soil's ability to supply N during the growing season and predicts the N fertilizer rate required to maximize rice yield. Rice is a very energy and management intensive crop and the ability to apply N fertilizer on a field-specific basis is a major step towards increasing the sustainability of rice production systems, while reducing the potential for negative environmental impacts.

Results
N-STaR is now released for Mid-South rice produced on silt loam and clay soils. During the first year of wide-scale use, two trends were observed. Roughly 50% of the samples processed through the N-STaR lab reported N rate recommendations that were significantly less than what the producer had intended to apply resulting in increased profitability through N fertilizer savings. The remainder of the samples processed resulted in N rate recommendations equal to or slightly higher than the current N rate recommendation. In research locations and production fields where N-STaR recommended more nitrogen fertilizer, there was a significant yield increase. Nitrogen applications on a field-specific basis is a major step towards securing long-term sustainability of Arkansas rice production. N-STaR provides a scientific basis for the need to apply more N to maximize rice yields in some fields. N-STaR provides a field-specific recommendation to maximize rice yield and profitability and N-STaR should reduce potentially negative environmental impacts associated with rice N fertilization.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

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
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

Drought conditions and extreme high temperatures were prevalant in 2012. Forage production was reduced sharply due to weather conditions and cattle production was thus affected. Non-irrigated row crop production was negatively affected by 2012 weather and while irrigated yields were surprisingly good, the quality of certain crops was affected. For essentially all animal and crop production, the drought and heat increased production costs, including increased water costs for irrigation, supplemental hay and feed costs and costs for cooling in CAFOs.

Biofuel production in Arkansas has received some attention from investors, but the opportunities for biofuels in the state hinge upon policies that have long term consequences. While Arkansas has abundant feedstocks for biofuel production, the infrastructure for processing feedstocks into biofuels is largely absent.

In general, managing timberland in the Midsouth has been unprofitable for several years. Thus the interest among land owners and managers has been very weak. As economic prospects for timber and forest management return, the interest in implementing best practices will increase.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The Discovery Farms uses a Stakeholder Advisory Committee to provide evaluation and feedback for the Program. The Discovery Farms is also conducting a mail survey for producers in the Illinois River Watershed. The Advisory Board for our Watershed Steward program gives feedback on success of the program in addition to a pre and post survey at

meetings for evaluation.

The best measure of success for the N-StaR program is the rate of adoption for this novel technology. N-StaR is now only two years old and the soil testing lab processed 3800 N-StaR samples in 2012.

Key Items of Evaluation

3800 N-StaR soil samples were submitted and analyzed by the soil testing laboratory in 2012.