

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

**Program # 5**

**1. Name of the Planned Program**

Climate Change - Ecosystem and Environmental Quality and Management

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
104	Protect Soil from Harmful Effects of Natural Elements	5%		10%	
111	Conservation and Efficient Use of Water	11%		10%	
112	Watershed Protection and Management	12%		10%	
121	Management of Range Resources	13%		15%	
123	Management and Sustainability of Forest Resources	9%		10%	
132	Weather and Climate	10%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
134	Outdoor Recreation	5%		0%	
135	Aquatic and Terrestrial Wildlife	8%		5%	
136	Conservation of Biological Diversity	4%		5%	
141	Air Resource Protection and Management	5%		5%	
205	Plant Management Systems	5%		5%	
403	Waste Disposal, Recycling, and Reuse	5%		5%	
605	Natural Resource and Environmental Economics	3%		10%	
	<b>Total</b>	100%		100%	

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

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

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	7.0	0.0	6.0	0.0
Actual Paid Professional	18.0	0.0	15.0	0.0
Actual Volunteer	9.8	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
500000	0	598390	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
500000	0	598390	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
2395112	0	3310012	0

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

### 1. Brief description of the Activity

- Design and conduct research
- Submit grant proposals
- Produce scientific publications
- Specialty conferences to address environmental issues of concern to Oklahoma,
- An Environmental Quality and Waste Management publications series
- A website that expands upon the information presented in the publication series, providing the range of information
- Develop Mesonet weather-related decision tools
  - A high-visibility symposium series will share high quality research and extension programs with technical and lay audiences.
- Poultry Waste Management Education
- Water Quality educational programs

### 2. Brief description of the target audience

Scientists, students, related agencies (Federal, State, private), land owners, farmers, ranchers, communities, consumers, land developers, state legislators, commodity groups, community leaders

### 3. How was eXtension used?

Oklahoma Cooperative Extension Service has provided leadership for the Prescribed Fire Community of Practice for eXtension. Goal is to have 100 FAQ and 30 articles ready for the 2013 launch of the site.

Josh Payne, working with a team from Oklahoma State, North Dakota State, and Cornell University developed a comprehensive learning module addressing livestock and poultry mortality management. Twenty-five FAQ videos were developed by OSU and have been posted on eXtension Animal Manure Community of Practice website. <http://www.extension.org/pages/28022/livestock-and-poultry-mortality-composting>

Doug Hamilton wrote 3 web pages and Scott Frazier wrote one webpage for the eXtension anaerobic digestion website. <http://www.extension.org/pages/26608/introduction-to-biogas-and-anaerobic-digestion>

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

**1. Standard output measures**

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	63045	4866407	3450	330000

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

**Patent Applications Submitted**

Year: 2012  
 Actual: 0

**Patents listed**

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

**Number of Peer Reviewed Publications**

2012	Extension	Research	Total
<b>Actual</b>	16	18	34

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

**Output Target**

**Output #1**

**Output Measure**

- Grant proposals written and submitted

<b>Year</b>	<b>Actual</b>
2012	55

**Output #2**

**Output Measure**

- Manuscripts submitted for consideration of peer-reviewed publication

<b>Year</b>	<b>Actual</b>
2012	104

**Output #3**

**Output Measure**

- Extension conferences, workshops and training sessions

<b>Year</b>	<b>Actual</b>
2012	221

**Output #4**

**Output Measure**

- Research and Extension reports and fact sheets

<b>Year</b>	<b>Actual</b>
2012	42

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

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

O. No.	OUTCOME NAME
1	Number of poultry producers and poultry litter applicators acquiring initial waste management certification and number maintaining certification
2	Number of animal waste analyses conducted for land application of beef, dairy or swine waste.
3	Number of animal waste analyses conducted for poultry litter application
4	Peer-reviewed publications
5	Number of users accessing website designed to deliver information about water policy, conservation and efficient use
6	Number of web-based weather related decision tools provided through Oklahoma Mesonet to improve crop and livestock production and safety and/or reduce costs
7	Survey of landowner attitudes toward prescribed fire
8	Climate-driven implications for plantation forestry in the southern Great Plains
9	Mechanisms to understand bird distributions in dynamic landscapes
10	Invasive plants in Oklahoma grasslands
11	Oklahoma 4-H High Adventure Program
12	Natural Stream Restoration and Enhancement Education, Demonstration, and Outreach in the Illinois River Basin
13	Ground Water Mechanisms of Erosion and Failure
14	Solute and Contaminant Transport between Streams and Alluvial Floodplains
15	Alternative Manure Technologies Video Series
16	New Abatement Technologies for Nut Harvester Pick Up Machines
17	Particulate Matter Abatement Technology

## **Outcome #1**

### **1. Outcome Measures**

Number of poultry producers and poultry litter applicators acquiring initial waste management certification and number maintaining certification

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

- 1862 Extension

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

Change in Action Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	488

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

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

The 1998 Oklahoma Registered Poultry Feeding Operations Act and the Poultry Waste Applicators Certification Act were originally established in response to concerns about phosphorus from poultry litter waste polluting important water resources.

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

As set forth in the Acts, all poultry production operators and poultry waste applicators must complete an initial nine-hour series of Poultry Waste Management Education (PWME) sessions followed by continuing education. In 2012 the Oklahoma Cooperative Extension Service Poultry Waste Management Education Program continued to provide the required training, addressing water quality concerns associated with improper or excessive land application of poultry litter.

The Poultry Waste Management Education program now encompasses much more than the I-9 and Continuing Education classes. Program activities conducted during 2012 included:

- A newly redesigned website offering fact sheets, links and schedules in a more user-friendly format
- Publication and distribution of a comprehensive Poultry Litter Nutrient Management Guide and a biannual newsletter, Poultry Practices
- Updated video presentations
- Innovative research projects to fuel new and timely Continuing Education topics
- Redesigned database of producer education records for faster data retrieval and verification of class attendance

## **Results**

A survey of 169 producers attending 2012 Continuing Education classes reported that:

- 100% thought the class topics were timely and fit their needs
- 100% thought the classes matched their level of experience
- 100% thought the new 2 hour class length is appropriate
- 99.4% thought the smaller class size contributed to an improved learning experience

Reduction in poultry waste applied in nutrient-limited watersheds

Increase in poultry waste exported out of NLWs and out of state

Improved communication with poultry producers and poultry waste applicators via website and on-line tools

Streamlined system for tracking and reporting education attendance supports regulatory compliance

Reduction in P loading and P concentrations in nutrient limited watersheds

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

#### Outcome #2

##### 1. Outcome Measures

Number of animal waste analyses conducted for land application of beef, dairy or swine waste.

##### 2. Associated Institution Types

- 1862 Extension

##### 3a. Outcome Type:

Change in Action Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	205

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

**Issue (Who cares and Why)**

**What has been done**

**Results**

#### 4. Associated Knowledge Areas

<b>KA Code</b>	<b>Knowledge Area</b>
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
205	Plant Management Systems
403	Waste Disposal, Recycling, and Reuse

#### Outcome #3

##### 1. Outcome Measures

Number of animal waste analyses conducted for poultry litter application

##### 2. Associated Institution Types

- 1862 Extension

##### 3a. Outcome Type:

Change in Action Outcome Measure

##### 3b. Quantitative Outcome

<b>Year</b>	<b>Actual</b>
2012	581

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

**Issue (Who cares and Why)**

**What has been done**

**Results**

#### 4. Associated Knowledge Areas

<b>KA Code</b>	<b>Knowledge Area</b>
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
205	Plant Management Systems
403	Waste Disposal, Recycling, and Reuse

## **Outcome #4**

### **1. Outcome Measures**

Peer-reviewed publications

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

- 1862 Extension
- 1862 Research

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

Change in Action Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	34

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

**Issue (Who cares and Why)**

**What has been done**

**Results**

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

<b>KA Code</b>	<b>Knowledge Area</b>
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
134	Outdoor Recreation
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

## **Outcome #5**

### **1. Outcome Measures**

Number of users accessing website designed to deliver information about water policy, conservation and efficient use

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

- 1862 Extension
- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	3474

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

**Issue (Who cares and Why)**

**What has been done**

**Results**

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

<b>KA Code</b>	<b>Knowledge Area</b>
111	Conservation and Efficient Use of Water
605	Natural Resource and Environmental Economics

## **Outcome #6**

### **1. Outcome Measures**

Number of web-based weather related decision tools provided through Oklahoma Mesonet to improve crop and livestock production and safety and/or reduce costs

### **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)

The Oklahoma Mesonet has assembled and created weather-based tools that give Oklahoma agricultural producers and natural resource managers the opportunity to move from calendar-based to weather-based farm management. Weather-based farm management can reduce farm inputs, increase crop yield and quality, improve farm sustainability, provide new integrated pest management (IPM) opportunities, improve environmental protection and expand crop marketing information. The Oklahoma Mesonet through Mesonet.org for desktops and tablets and m.Mesonet.org for mobile devices provides farmers and ranchers weather-based risk management tools and information.

Weather-based management has been made possible because the Oklahoma Mesonet operates one of the most data-rich weather networks in the world. New weather data are transmitted every 5 minutes from a statewide system of 120 automated weather-monitoring towers. This constant flow of quality assured, research-quality weather data are used to maintain a wide spectrum of weather and agricultural decision support products made available via traditional and mobile websites. The challenge in implementing weather-based agricultural management includes increasing producer comfort with computer operation, expanding grower weather knowledge, simplifying weather data display, and shaping decision support products to meet day-to-day farm management needs.

#### What has been done

Oklahoma State University, the University of Oklahoma and the Oklahoma Climatological Survey (OCS) through the Oklahoma Mesonet have created multi-faceted agricultural and natural resource extension outreach and research programs. Mesonet.org provides desktop and tablet access to weather data and products at no cost to Oklahoma farmers and ranchers. An Agriculture section within Mesonet.org organizes decision support products by crop and livestock commodity. Ongoing extension/outreach efforts inform growers about available products and introduces them to weather-based farm management tools via farm show exhibits, educational presentations, television, web tutorials, and printed materials.

2012 was a major year for agriculture and Mesonet. In August 2012, the Mesonet Agweather website was replaced with an Agriculture section within the Mesonet.org website. As part of the Agriculture section launch products and information on the Agweather website were reformatted

for the Mesonet.org website and as part of this process designed for use on mobile devices, especially tablets. The Cattle Comfort Advisor was added as a fully operational advisory.

Plant Available Water maps were added. These provide an estimate of soil water for plant growth from the soil surface down to four inches, the soil surface down to sixteen inches and the soil surface down to thirty-two inches. These maps provide a statewide view of soil water in inches that can be compared to rainfall in inches and evapotranspiration in inches.

New long-term average maps were brought online in 2012. These can be used to compare any month against any other month or deviation from the long-term average for any data set from the Oklahoma Mesonet system.

### **Results**

The informal feedback from the Oklahoma agricultural community is very complimentary of the Oklahoma Mesonet. Farmers and ranchers are turning to the Mesonet to monitor rainfall and soil moisture, especially in this time of historic drought. To minimize drift hazard, they are using the Mesonet Drift Risk Advisor. Monitoring soil temperature has become more important as seed costs have climbed dramatically in the last couple of years. When determining the best time to bale hay or harvest, growers monitor current and forecast relative humidity.

One producer noted how he used Mesonet to know if a far away field received rain or not. Knowing rainfall amounts lets him avoid wasted trips. A wasted trip means lost revenue, time and unnecessary emissions. A hay producer stated he uses the Mesonet to monitor humidity changes for hay baling, without having to drive to the field. This producer not only saves time and money, the Mesonet allows him to monitor the field conditions from home and get more sleep. This better rested farmer is a safer farmer. Near Willow, OK a producer used 10 and 24-inch soil moisture to decide not to plant dry land cotton. He saved the input costs and reduced his financial risk.

Mark Hodges, past Executive Director for the Oklahoma Wheat Commission, has used Oklahoma Mesonet soil moisture and rainfall maps to build customer relations with international grain buyers of Oklahoma wheat. While Mark has not put a direct value on Oklahoma Mesonet data, he has stated that Mesonet information has been part of Oklahoma grain sellers marketing millions of bushels of wheat over multiple years to buyers in Mexico.

Mesonet serves agricultural and horticultural enterprises on several levels. Dennis Brigham of Bentley Turf Farms told how he turns to Mesonet Agweather for weather information to help him schedule sod installation by his company's installation crews. One day north of Mustang, a Bentley Turf Farms' crew was busy laying sod, while to the southwest a severe storm cell spawned a tornado. Dennis used the radar on the Mesonet Agweather website to track the storm. He determined that there was a high probability the tornado would track over the location where the crew was laying sod. Mesonet Agweather gave him enough lead-time to contact the crew leader and get the crew to travel south out of the tornado's track. On this day, Mesonet Agweather quickly transitioned from being a day-to-day scheduling tool to a life and death safety tool.

An economic survey completed by OU graduate student Kim Klockow using recognized economic analysis techniques, estimated that the 10% of Oklahoma crop land being managed with Oklahoma Mesonet data saved \$8 million in production costs in 2008. Miss Klockow was only able to survey crop producers. This estimated value does not include the Mesonet value to livestock producers.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
205	Plant Management Systems

#### Outcome #7

##### 1. Outcome Measures

Survey of landowner attitudes toward prescribed fire

##### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

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

The lack of prescribed fire has been identified as a major natural resource concern in Oklahoma. The OCES has spent significant resources to address this issue. However, information on public attitudes and perceptions was lacking to direct these outreach activities. Thus, we designed a survey to gather the necessary information to provide resource agencies so that their effort is directed appropriately to achieve an increase in prescribed fire acreage and an increase in public acceptance of fire as a management tool.

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

We designed two questionnaires to assess perceptions of Oklahoma residents and agricultural producers to prescribed fire and eastern red cedar encroachment. To achieve this, we mailed 1,000 questionnaires to agricultural producers and another 1,000 to the general public. Follow-up phone surveys were obtained from 10 percent of all nonrespondents to assess bias.

We created three new fact sheets, a new fire effects video, and a new community of practice for eXtension. We used a combination of presentations, fact sheets, web sites, and circulars to disseminate information from this work. All outreach was directed based on survey research results. Our general findings were that landowners were most concerned about liability, 70% were not aware that prescribed fire associations existed, and do not burn during the growing season.

We delivered an oral presentation of these findings at the 24th Tall Timbers Fire Ecology Conference; that presentation resulted in a peer reviewed paper. Research results were also presented to the Noble Foundation Agriculture Division to aid them in their outreach efforts to private landowners within the state of Oklahoma.

### **Results**

The Oklahoma Prescribed Fire Council is initiating a state-wide liability insurance program which should be available for 2013. This should significantly decrease liability concerns for landowners in regards to prescribed fire that were identified from our research. Three additional fire associations have been formed in Oklahoma based on work to increase knowledge of their benefits. One of the more significant changes in condition over the past five years is that the use of prescribed fire is now being considered beyond the typical dormant season. This will allow more land area to be properly managed.

Additionally, we were able to modify CRP policy in Oklahoma to allow for fire disturbances closer to historical frequencies. This impacts over 1,000,000 acres of land in Oklahoma.

This will impact 47 counties in the Southern Great Plains. Based on the research results, we conducted multiple extension events to educate landowners and land managers. These included: two summer fire field days which were attended by over 100 participants, nine land management field days (over 350 participants), and over 30 presentations to various audiences in Oklahoma, Nebraska, and Kansas. These included presentations at the Nebraska State Habitat Meeting, Oklahoma Chapter of The Nature Conservancy Board of Directors Meeting, National Farm Bureau Young Farmer Meeting, Oklahoma Wildlife Management Association Annual Meeting, Pheasants Forever Annual Meeting, National Bobwhite Conservation Initiative Meeting, NRCS Fire Trainings, and an NRCS webinar. Additionally, we disseminated information to resource professionals in the state of New Mexico to assist with their prescribed fire program. Thus, the entire project is based on Oklahoma stakeholder responses.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
121	Management of Range Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
205	Plant Management Systems

## **Outcome #8**

### **1. Outcome Measures**

Climate-driven implications for plantation forestry in the southern Great Plains

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

- 1862 Research

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2012	0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

The current drought in Oklahoma illustrates some stresses on tree growth that are predicted to become more frequent events due to climate change. Temperature-mediated increases in woody plant water use and water stress can affect the distribution of forest ecosystems at the grassland-forest ecotone of the southern Great Plains, with repercussions for industrial forestry in the region. Species in these forests grow near the moisture limit of their ranges. Small increases in temperature can increase vapor pressure deficits (VPD), which in turn may increase tree water use and hasten mortality during severe drought.

In addition to heat and water stress, climate change is predicted to increase the frequency and severity of damaging storms. Ice damage, in particular, can be costly. Thus, it is important to predict the characteristics of trees most susceptible to such damage.

#### What has been done

We engaged in a series of studies to address aspects of climate-mediated tree loss and seedling survivorship. Significant findings from that work indicate that trees of larger diameter were more susceptible to mortality from ice damage. The site condition where seedlings are establishing, e.g., under open or more shaded conditions, had a large bearing on drought tolerance. Increasing temperature from 30 to 33 degrees C resulted in more negative xylem water potentials and resulted in fewer days until transpiration was reduced after water was withheld. Ultimately, seedlings grown at 33 degrees C died 13% earlier than seedlings grown at 30 degrees C during terminal drought. Results suggest if temperature and droughts increase in the future, the forest-grassland ecotone could shift because increased seedling mortality will prevent recovery following disturbance of overstory trees.

Finally, results from a comparative mulch study showed that tree-based mulch benefits plant growth and survival by maintaining greater soil moisture, decreasing competition from weeds, and moderating soil temperatures compared with not using mulch. In particular, Eastern redcedar (*Juniperus virginiana*) provided similar benefits as other common wood mulches and is a viable forest product.

#### Results

This study will assist forest managers to select genotypes to improve forest productivity over the wide-range of site conditions likely to be available in the region over the next several decades.

The research contributed to the development of a climate change/decision support model using multiple long-term weather and forest growth and yield data sets. This model will facilitate the viability of beneficial forest management practices in the face of pending climatic changes.

The research led to the publication of 2 peer-reviewed publications, 3 peer-reviewed technical bulletins, and a presentation at a national meeting in 2012.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
132	Weather and Climate

#### Outcome #9

##### 1. Outcome Measures

Mechanisms to understand bird distributions in dynamic landscapes

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

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

Land use changes in the Southern Plains are reflected in the population responses and habitat selection of wildlife. In broad terms, grassland species have been declining in population and loss of range due largely to the conversion of native grasslands to shrubland from encroaching woody vegetation, to cropland from agricultural development, and to a mix of residential, corporate, and industrial land cover in urbanizing areas. The responses of grassland birds to these land use changes have been overwhelmingly negative, both across Oklahoma and more generally across North America. In contrast, some species of birds have increased in population in the Southern Plains and are expanding their distribution. The precise mechanisms through which these species have been able to exploit the features of novel environments, however, are seldom clear. We also lack the ability to determine if the species expanding are actually choosing habitats that confer an advantage or if they are falling victim to the phenomenon of "ecological traps" in which

an area is perceived to be high quality but actually is not. A better understanding of these mechanisms can aid conservationists and land managers in providing the types of conditions most beneficial to the species of greatest conservation need.

Citizen science programs featuring the contributions of amateur birders provide critical information for avian conservation. In particular, the North American Breeding Bird Survey is the longest-running, standardized, continent-wide survey of birds during the spring and summer breeding seasons. The Christmas Bird Counts, stretching back 113 years, and the newer Great Backyard Bird Count specifically target bird distribution and abundance during the winter months. These programs are the only dedicated means to obtain population and distribution estimates for Arctic-breeding species that are poorly sampled by the Breeding Bird Survey. The Southern Plains region provides a significant amount of habitat for multiple species that are rare elsewhere including Cackling Goose (*Branta hutchinsii*), Harlan's Red-tailed Hawk (*Buteo jamaicensis harlani*), Harris's Sparrow (*Zonotrichia querula*), and Smith's Longspur (*Calcarius pictus*). Without a concerted effort from birders in Oklahoma, our ability to track conditions for these and other species is greatly diminished.

### **What has been done**

We address these issues from the dual perspectives of field research on priority species and outreach activities to encourage participation in citizen science. With respect to field research, we conducted two relevant studies in 2012 that focused on species that have undergone dramatic changes in habitat use and/or distribution. Mississippi Kite (*Ictinia mississippiensis*) is a medium-sided raptor that has become increasingly abundant in the Southern Plains and makes use of residential areas (primarily parks and neighborhoods with large shade trees) for nesting. We found that while kites may have some preference for certain species of trees as nest sites, they were far more influenced by the abundance of prey (cicadas and grasshoppers) in the immediate vicinity. A second study of Western Kingbird (*Tyrannus verticalis*) quantified nest success in this songbird that along the eastern edge of its distribution in Oklahoma has largely abandoned traditional territories in grassland and rangelands for what might be a unique semi-colonial nesting behavior in urban areas. We documented both high nest success and unprecedented nesting density of these birds in our population.

With respect to citizen science participation, we engaged students and other citizens through coverage of sponsorship of various events at community meetings (e.g., the Payne County Audubon Society and Oklahoma Ornithological Society), on dedicated blogs, through email listservs and social media, and on a local radio station.

### **Results**

Poster presentations of the Mississippi Kite and Western Kingbird studies were presented at the annual science meeting of the Oklahoma Ornithological Society and have both been accepted for the international Wilson Ornithological Society annual meeting in 2013. These studies are significant in demonstrating the importance of food availability as a species predictor of wildlife habitat (kites) and the development of a novel nesting strategy in terms of habitat selection and interaction with conspecifics (kingbird). These studies provide fruitful ground for additional investigations that will increase our ability to manage native wildlife under rapidly changing conditions in urbanizing areas.

Citizen science participation in the region increased dramatically in 2012. For example, Payne County set a new record for participation in the Great Backyard Bird Count, briefly occupying a

national top 10 position among communities reporting data. Ultimately, levels of participation in that event placed Stillwater, OK on par with Houston, TX in terms of total checklists submitted, indicating a far greater likelihood that Stillwater participants tended to submit more than one checklist. The relevant blogs in which citizen science topics were addressed were accessed 26,311 times in 2012.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

#### Outcome #10

##### 1. Outcome Measures

Invasive plants in Oklahoma grasslands

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Action Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

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

The increased number of acres invaded by exotic plant species (e.g., grasses and legumes) throughout Oklahoma has been identified as a major threat to the state's natural resources. In addition, the absence of a centralized source of information concerning invasive species identification and management has hindered the ability of land managers to control invasive species on their land.

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

Concurrent research projects related to this topic included efforts to assess the efficacy of patch-burn grazing in combination with spot-spraying to control sericea lespedeza; 2) a project to assess soil chemical changes occurring following removal (herbicide treatment) of salt cedar; and 3) an investigation into small mammal populations in tallgrass prairie invaded by Old World bluestem. In addition, we contributed to the development of the Oklahoma Invasive Plant Council (OkIPC), an organization whose goal is to facilitate efficient and effective management of invasive

plants for the protection of the economic and natural resources of Oklahoma's private and public lands and waters.

### **Results**

Over the past year, OkIPC has continued the coordination and development of practices focused on the reporting of kudzu invasions in Oklahoma by promoting the communication among federal, state, and local officials. We have directly increased the knowledge of over 1200 resource professionals and land managers concerning the topic of invasive plant species versus noxious weeds, characteristics of invasive species, management practices to control invasive species, and alternative native species to use in their practice. Management of over 10,000 acres in OK has been altered as a result of this information. Research results were presented at state, regional, and international meetings of the Oklahoma Invasive Plant Council, Society for Range Management (Spokane, WA), Ecological Society of America meeting (Portland, Oregon), OK Section of the Society for Range Management and OK Section of The Wildlife Society. In addition, this research resulted in three peer-reviewed journal articles in 2012.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
205	Plant Management Systems

### **Outcome #11**

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

Oklahoma 4-H High Adventure Program

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

- 1862 Extension

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

Change in Action Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	0

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

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

In his 2006 book *Last Child in the Woods*, Richard Louv tells of schools eliminating hands-on nature study from the curriculum in an effort to increase standardized test scores. Beyond the changes in school curriculum, the busy life of today's over-stretched and over-stressed parents allow little time for outdoor activities.

Unlike earlier generations, many of today's parents see the outdoors as a dangerous place. They fear strangers and kidnappings, gangs and drug dealers taking over parks and vacant corner lots, and encroaching wildlife from mountain lions to virus-bearing mosquitoes that have been sensationalized by the media. We have scared children straight out of the woods and fields. The 4-H Program, and in particular the 4-H High Adventure Program, is uniquely situated to help address this issue.

4-H is a youth development education program that emphasizes positive youth-adult interaction and peer leadership. The Oklahoma 4-H High Adventure Program is an outdoor leadership program for teens intended to develop character and integrity in young people through the teaching of teamwork, leadership, and outdoor skills and allows them to share their knowledge with others. By experiencing the challenge of the out-of-doors, participants grow personally, developing an understanding of themselves and their limitations while instilling a new respect for the natural environment.

### **What has been done**

The goal of all 4-H programs is youth development. Decision making, teamwork, problem solving, being responsible and having high self-esteem are just a few of the many skills 4-H helps to develop to enable youth to be productive and positive adults in our society.

The 4-H High Adventure Program involves youth who have an interest in the out-of-doors and welcomes them into an accepting, caring group. This program addresses Belonging, Mastery, Independence and Generosity. These Essential Elements and are critical to an effective 4-H experience.

To ensure that youth development and safety remain at the forefront of this program, specific objectives were developed:

1. Develop and strengthen the mental and physical skills of youth as required of a high adventure camper.
2. Offer a challenge for youth to accomplish a high level of self-confidence, individual worth, personal growth, and achievement.
3. Strengthen interpersonal relationship skills of so as to become a functioning team member.
4. Develop leadership and other life skills to assist youth to become contributing members of society and their families.
5. Develop an appreciation for and respect of natural resources by teaching environmentally correct backpacking and camping skills.
6. Design a comprehensive educational program for older youth that encompasses 4-H project areas including public speaking, recreation, outdoor life, photography, conservation of natural resources, consumer education, food nutrition, food conservation and safety, health, environmental awareness, personal development, clothing, safety, citizenship and leadership.

### **Results**

The Oklahoma 4-H High Adventure Program had its beginnings in 1982 but was dropped in 1992 as lead staff left Oklahoma 4-H. Renewed interest in this program began in 2008 with the increased focus on primitive camping opportunities for 4-H members.

A mandatory one-day training is held in the spring for participants and one parent and/or guardian to explain the program, requirements, fees and expectations. Participants attend a weekend

training that focuses on safety, health, personal hygiene, campsite selection, food safety and preparation and other topics that address successful wilderness backpacking.  
The climax of the program is a 7-day trip backpacking experience to the Pecos Wilderness area in New Mexico. This Wilderness area is located in both the Carson and Santa Fe National Forests and encompasses approximately 230,000 acres.  
Selected comments from participants:  
I have a new respect for myself and what I am capable of achieving.  
I will practice Leave No Trace principles at home.  
It is a week my daughter and I will have in common for the rest of our lives. (adult chaperone and father of participant)  
Certified adult volunteers serve as positive role models and mentors for kids. They model and teach character while providing instruction in the proper use of and respect of equipment used in a wilderness camp setting.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation

#### **Outcome #12**

##### 1. Outcome Measures

Natural Stream Restoration and Enhancement Education, Demonstration, and Outreach in the Illinois River Basin

##### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

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

Natural stream banks and the riparian land around them help to maintain water quality and control sedimentation in the streams. They also provide food and habitat for the aquatic and terrestrial communities. When these areas are degraded, either from human interference or natural occurrences, they cease functioning to their full capacity. Natural stream restoration and enhancement is new way designing stream restoration projects that uses natural materials

instead of concrete to stabilize the bank and uses native plants to restore the riparian area. It also uses engineering techniques such as bank sloping and installing in-stream rock and log structures to reduce velocity and direct the flow back to the center of the stream. Because the techniques used for this type of stream restoration are new, there is a definite need for training for this type of design and implementation.

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

A project was initiated by Oklahoma Cooperative Extension and the Oklahoma Conservation Commission (OCC) to restore 11 degraded stream bank sites in the Illinois River Basin. This project repaired 6,657 feet of stream bank that had significant erosion problems. Educating and working with area landowners allowed OCC to begin the process of enrolling additional acreage in the Conservation Reserve Enhancement Program. An Additional goal of this project was to educate a wide variety of people on the benefits of using bioengineering techniques to reduce erosion and repair streams to a more natural state through workshops, field days and on-site community education. The education effort built local expertise on the design and construction elements. This will help ensure that this project's benefits continue long-term by maintaining a healthy riparian system which provides additional benefits to the stream and the stream corridor. Information gleaned from additional monitoring of the sites is being used in conjunction with the restoration project. Combining this information will be a useful tool in determining which techniques work best in particular stream orders.

#### **Results**

This work has laid the groundwork for an expanding industry of natural stream restoration within Oklahoma, and partnerships have been formed between several state and federal agencies in part because of this project. As a result of workshops, field days, on-site community education and conference events, over 1,250 individuals have been educated and trained on the principles and techniques of natural stream restoration. In addition, over 30,000 people have been introduced to the idea of natural stream restoration through newspaper articles and television segments. This project has shown that in general, Oklahomans are willing to pay \$85.63 per year for improvements to stream banks, and \$16 per year for improvements in water quality and clarity. Additionally, Oklahomans think they should be compensated by \$140 per year for the degradation of water quality. The city of Tahlequah recently passed a bond issue that includes money for additional stream work in their community. City officials said the four restoration sites completed in Tahlequah served as a spark for the City to continue improving Town Branch Creek and the land adjacent.

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

<b>KA Code</b>	<b>Knowledge Area</b>
112	Watershed Protection and Management

#### **Outcome #13**

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

Ground Water Mechanisms of Erosion and Failure

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

- 1862 Research

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2012	0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

Excessive sediment is one of the most common surface water pollutants across the world. Much of the sediment originates from stream banks in many watersheds. The interaction between surface water and shallow ground water in predicting sediment transport is not fully understood. The importance of ground water seepage and piping with respect to other fundamental processes of river erosion is largely unknown, although seepage and piping features are observed on stream banks spanning a wide range of geomorphologic conditions. Specific seepage and piping mechanisms that cause bank failure may never manifest themselves as transparent features on unstable banks. This research hypothesizes that multiple ground water flow mechanisms, combined with fluvial processes, affect the occurrence and timing of stream bank erosion and failure. Ground water forces can act over extended periods to destabilize banks between flow events. Specific seepage mechanisms become prevalent under certain predictable stream bank stratigraphy and hydrologic conditions.

#### What has been done

Research currently underway includes conducting three-dimensional soil column experiments to determine the occurrence and prevalence of different seepage erosion mechanisms (i.e., seepage gradient forces and undercutting) and to determine the sequence of erosion steps leading to failure by ground water flow through soil pipes. Laboratory experiments are also investigating the fluvial resistance of soils subjected to seepage forces using submerged jet tests. A more fundamental detachment model is being developed for modeling sediment transport that can account for seepage gradient forces. Results from the laboratory experiments are being examined at the field scale through innovative field experiments. Field sites in Mississippi and Oklahoma have been instrumented to monitor pore-water pressures, seepage erosion, and seepage gradient forces during controlled seepage-induced failure experiments. Research activities this year investigated the role of seepage and piping on stream bank, hill slope, and gully erosion. This research continued to demonstrate the importance of seepage erosion processes in leading to erosion, failure, and sediment loading to streams. Through additional support provided by a National Science Foundation (NSF) grant, research activities have included evaluating a stream bank stability model for predicting lateral retreat on composite stream banks. Seepage erosion and failure experiments were conducted and analyzed for sandy loam and loamy soils in three-dimensional laboratory-scale boxes. Theoretical research has been performed on developing and evaluating a mechanistic detachment model to predict soil erodibility due to fluvial and seepage forces. Research also included soil piping experiments utilizing an innovative constant-head trench system to conduct constant head soil pipe and internal erosion experiments in two contrasting stream banks. Construction has been completing

on the Cow Creek Stream bank Research Facility, establishing a stream bank erosion and failure research facility.

### **Results**

Impacts of this research include transforming the way in which stream bank, hill slope, and gully erosion processes are modeled for engineering design and analysis through development of fundamental erosion equations, emphasizing the role of groundwater mechanisms; development and testing of new tools for measuring soil resistance to erosion; documenting the importance of process-based modeling in the billion dollar industry of stream restoration and rehabilitation; and quantifying contributions of stream bank erosion and failure in leading to sediment and phosphorus load in scenic rivers in eastern Oklahoma to document impacts of conservation programs such as the Conservation Reserve Enhancement Program (CREP). Research on the role of ground water processes for stream bank stability has significantly extended theory on the role of ground water in erosion and provided new tools for multidisciplinary researchers to determine the importance of seepage erosion and undercutting for numerous soils, hydrologic, and environmental conditions. Stream bank modeling demonstrated the importance of considering pore-water pressure effects for predicting lateral stream bank retreat or the design of stream bank protection measures. The more fundamental detachment model for erosion by fluvial and/or seepage forces can be used in place of the commonly utilized excess shear stress model with parameters that can be derived from flume tests or/and jet erosion tests. Soil piping and internal erosion research highlighted the need for improved models of these processes for predicting dam, levee, stream bank and gully failures.

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

<b>KA Code</b>	<b>Knowledge Area</b>
112	Watershed Protection and Management

### **Outcome #14**

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

Solute and Contaminant Transport between Streams and Alluvial Floodplains

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

- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	0

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

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

The prevailing wisdom is that phosphorous transport place primarily in surface runoff. A growing collection of research indicates that subsurface transport of phosphorus can be significant. Vegetative filter strips are proposed to protect aquatic organisms from pesticides in runoff, but there is debate regarding the efficiency and filter size requirements. The controversy is largely due to the belief that no quantitative methodology exists for predicting runoff buffer efficiency when conducting acute and/or chronic environmental exposure assessments. Significant research progress has occurred on quantifying solute and contaminant transport between riparian floodplains and streams. It is hypothesized that hydrologic heterogeneities (e.g., macropores and gravel outcrops) in the subsurface of floodplains play an integral role in impacting flow and contaminant transport between the soil surface and shallow alluvial aquifers.

### **What has been done**

Innovative field studies, including plot scale (1 by 1 m and 3 by 3 m) solute injection experiments along with geophysical imaging, were performed on both gravel outcrops and non-gravel outcrops. Research is also underway to quantify the magnitude of sediment and phosphorus loading from stream bank erosion and failure in sensitive watersheds in eastern Oklahoma. The research is quantifying the impact of riparian management practices in limiting sediment and phosphorus input from this source. This research demonstrated that even small floodplains can have heterogeneous flow pathways that can considerably impact the leaching potential of tracers and phosphorus through the soil. Research on streambank contributions of sediment and phosphorus suggests that riparian protection in the Barren Fork Creek watershed results in approximately five times reduction in kg of contributed water soluble phosphorus per year per meter of stream bank. Areas protected by riparian vegetation experienced at least four times less stream bank retreat over a seven year period. Previous research on pesticide transport and VFS by my research group has proposed a modeling approach that links the U.S. Environmental Protection Agency's (EPA's) PRZM/EXAMS with a well-tested process-based model for VFS (VFSSMOD). In research during the past year, we applied the modeling framework to determine (1) the most important input factors for quantifying mass reductions of pesticides by VFS in aquatic exposure assessments relative to three distinct U.S. EPA scenarios encompassing a wide range of conditions; (2) the expected range in percent reductions in acute and chronic estimated environmental concentrations (EECs); and (3) the differential influence of VFS when conducting acute versus chronic exposure assessments. This research utilized three, 30-year U.S. EPA scenarios: Illinois corn, California tomato, and Oregon wheat. A global sensitivity analysis (GSA) method identified the most important input factors based on discrete uniform probability distributions for five input factors: VFS length (VL), organic-carbon sorption coefficient (Koc), half-lives in both water and soil phases, and application timing. For percent reductions in acute and chronic EECs, VL and application timing were consistently the most important input factors independent of EPA scenario. The potential ranges in acute and chronic EECs varied as a function of EPA scenario and application timing. Reductions in acute EECs were typically less than percent reductions in chronic EECs because acute exposure was driven primarily by large individual rainfall and run-on events. Importantly, generic specification of VFS design characteristics equal across scenarios should be avoided. Dissemination of research findings on this objective during the past year have occurred through presentations at local, state, and national meetings and publication of peer-reviewed journal articles and conference proceedings during the project period

### **Results**

This research has wide reaching implications for how riparian floodplains throughout the world are managed. Billions of dollars are spent annually through governmental programs in North America and Europe to mitigate surface runoff, sediment, pesticide, and nutrient loads through conservation and restoration of riparian buffers. Although these management plans can be effective, this research hypothesizes that subsurface P transport could also be a contributing factor in certain conditions with this transport occurring along focused as opposed to diffuse pathways. Research on VFS illustrates that the revised pesticide assessment modeling framework offers the ability to elucidate the complex and non-linear relationships that can inform targeted VFS design specifications. In fact, approaches developed on the fate and transport of pesticides through VFS has been directly incorporated into environmental risk assessment procedures for pesticide use and registration in the European Union (EU) and is currently being considered by the US EPA as part of an improved risk assessment process for pesticides.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

#### Outcome #15

##### 1. Outcome Measures

Alternative Manure Technologies Video Series

##### 2. Associated Institution Types

- 1862 Extension

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

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

Producers are reluctant to adopt new technologies without firsthand experience with the technology. It is particularly difficult to get positive exposure for manure related issues in traditional media. Creative methods are needed to expose producers to useful technologies for handling and treating animal wastes.

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

Eleven videos highlighting innovative manure handling and treatment technologies were filmed,

edited, and produced by the Oklahoma Cooperative Extension Service. Videos were uploaded onto the OSU Waste Management Channel on YouTube to maximize exposure of the technologies. Technologies were selected working with partners in Arkansas, Louisiana, Texas, and Nebraska. We specifically sought out producers who have successfully adopted manure handling and treatment technologies on their farms. Technologies filmed were: a subsurface poultry litter spreader; a large-scale, poultry litter bailing operation; a between flock, broiler litter windrowing system; a rotary drum composter for poultry carcass disposal; a "weeping wall" solid-liquid separator for dairy manure; mechanically separated and composted dairy manure solids used as cow bedding; methane gas captured from a covered anaerobic lagoon used to incinerate swine carcasses; a "Biovator" style rotating drum swine carcass composter; lime enhanced precipitation of solids from alligator ranch wastewater; and vegetative treatment systems for feedlot runoff treatment.

### Results

In the three years since creation of the YouTube channel, the videos have been downloaded more than 23,000 times with a total viewing time of nearly 300 hours. Videos have been downloaded in all fifty states plus Guam, Puerto Rico, the US Virgin Islands and American Samoa. In addition to the United States, the videos have been seen by viewers in 147 countries on all continents. More than one third of all downloads were the result of online searches, which shows that the exposure has been consumer driven. Producers are actively seeking examples of manure technology and downloading the videos. Another source of downloads was videos embedded on websites -- manufacturers of equipment added a link from their home website to our videos demonstrating equipment use on-farm.

### 4. Associated Knowledge Areas

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

### Outcome #16

#### 1. Outcome Measures

New Abatement Technologies for Nut Harvester Pick Up Machines

#### 2. Associated Institution Types

- 1862 Research

#### 3a. Outcome Type:

Change in Knowledge Outcome Measure

#### 3b. Quantitative Outcome

Year	Actual
2012	0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

Nut harvesting has been identified as a major source of particulate matter emissions. In some areas, nut harvesting has been identified as the primary source of particulate matter emissions. Nut industries and regulatory agencies in several states are looking to implement new management practices or abatement technologies to reduce the particulate matter emissions produced during harvest.

#### What has been done

Dr. Buser is part of a research team that has designed and evaluated a low cost retrofit abatement device that can be used with existing pick-up machines to reduce particulate matter emissions. The research team includes Dr. Buser and researchers from the USDA-ARS Cotton Ginning Research Laboratory in Mesilla Park, NM, faculty from New Mexico State University, and Flory Industries in Salida, CA. In initial tests, the new technology was shown to remove 77 to 105 pounds of material per minute from the air stream. This is a major reduction. During the test the team identified several design parameters that should be addressed prior to further testing. The team has also developed several new concepts that they plan to evaluate on a laboratory scale in the near future.

#### Results

This innovative, and low cost, abatement technology design for nut harvesting pick-up machines provides producers the ability to remove more than 75 pounds of material per minute from the air stream. The significant reductions in particulate matter emissions achieved with this technology can improve the working conditions for the personnel operating the machinery and working in the immediate area

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
141	Air Resource Protection and Management

#### Outcome #17

##### 1. Outcome Measures

Particulate Matter Abatement Technology

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Action Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
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2012

0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

As federal and state PM regulations change in terms of the specified indicator (e.g. total suspended particulate, PM10, PM2.5, etc.), the basis for determining abatement technology efficiencies must change. In the 1970s, total suspended particulate (TSP) was the regulated pollutant and numerous reports were published comparing various cyclone designs and TSP collection efficiency. Currently, PM2.5 is a regulated pollutant and there are very few reports comparing cyclone designs and PM2.5 collection efficiency.

#### What has been done

A particulate matter abatement device evaluation system has been designed, developed, and constructed and has been used to evaluate baffle type pre-separators, series cyclones, and the scalability of cyclones. These studies have shown that two 1D3D cyclones in series were more effective (97%) than a single 1D3D cyclone (91%); used to define the optimum baffle placement and inlet air velocity in terms of collection efficiency for the baffle-type pre-separator; and provided fundamental scalability cyclone research which showed that collection efficiency for 10 micron PM decreased from 99.5% to 94.5% as cyclone diameter increased from 6 to 36 in. Currently studies are being conducted to directly compare different cyclone designs that are currently being used in industry. In addition to evaluating and improving current device/system designs, new abatement technologies are being developed such as a device for reducing PM emissions from almond and pecan harvesting operations.

#### Results

This research can be utilized by industry and regulatory agencies to predict the effectiveness of a given abatement technology or technologies to reduce particulate matter emissions from a source with defined characteristics.

Can be used in prescription technologies for multi-point facilities

Example of recent industry application: a feed supplement company was given a notice of violation for excessive emissions. This company was facing closure due to the quantity of particulate matter being emitted from the facility. In addition, the company had a market for the material been emitted so it was missing out on potential sales. The company invested about \$80,000 and installed new cyclones based on the criteria from this research and prior to the existing abatement devices. This system enhancement improved the facilities abatement system efficiency by 98%, increased average annual revenues by \$470,423, and kept the plant from closure.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
141	Air Resource Protection and Management

## **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**

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

### **Evaluation Results**

An economic survey of Mesonet users completed by University of Oklahoma graduate student, Kim Klockow, using recognized economic analysis techniques, estimated that the 10% of Oklahoma crop land being managed with Oklahoma Mesonet data saved \$8 million in production costs in 2008. Miss Klockow was only able to survey crop producers. This estimated value does not include the Mesonet value to livestock producers.

### **Key Items of Evaluation**