

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Ecosystem and Environmental Quality and Management including Weather and 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
104	Protect Soil from Harmful Effects of Natural Elements	5%		10%	
111	Conservation and Efficient Use of Water	20%		10%	
112	Watershed Protection and Management	15%		10%	
121	Management of Range Resources	5%		15%	
123	Management and Sustainability of Forest Resources	2%		10%	
132	Weather and Climate	5%		5%	
133	Pollution Prevention and Mitigation	5%		5%	
135	Aquatic and Terrestrial Wildlife	5%		5%	
136	Conservation of Biological Diversity	5%		5%	
141	Air Resource Protection and Management	13%		5%	
205	Plant Management Systems	10%		5%	
403	Waste Disposal, Recycling, and Reuse	5%		5%	
605	Natural Resource and Environmental Economics	5%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	9.0	0.0	14.0	0.0
Actual Paid	16.0	0.0	14.5	0.0
Actual Volunteer	1.4	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
165000	0	721895	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
165000	0	721895	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1680000	0	3577925	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Conduct multi-disciplinary research on grassland fuel modeling as part of an awarded Joint Fire Science Program grant.

Provide agriculture and natural resource management technical expertise for weather and climate data and models maintained and operated by the Oklahoma Mesonet.

Create and deliver weather and climate education for the general public, agriculture and natural resource sectors through OSU SUNUP TV, online video/audio tutorials, fact sheets, email newsletters, educational programs, seminars and workshops. Some extension materials developed in 2014 were part of the extension program objectives of the USDA NIFA AFRI Grazing CAP #2012-02355.

Design and conduct research

Forge collaborative relationships that build on current strengths in research in management.

Partner with state and federal agencies to address pressing needs in conservation.

Produce scientific publications; disseminate information through other print and online media outlets.

Conduct workshops, field days, and other personal information exchanges to promote issues and alternatives in natural resource management.

Submit grant proposals

Produce scientific publications

Conduct Poultry Waste Management Education

Develop and deliver weather and climate education for the general public and agricultural sector will be conducted through weather reports on TV through OSU SUNUP, online video/audio tutorials, printable information and fact sheets, email newsletters, educational programs, seminars and workshops.

Multi-disciplinary research on grassland fuel modeling will be conducted as part of an awarded Joint Fire Science Program grant.

Investigate and develop weather-related decision tools in the areas of wildland fire management, plant disease prediction, livestock environmental management, and crop heat units as they relate to agronomic crop stage.

Provide agriculture and natural resource management technical expertise for weather and climate data and models maintained and operated by the Oklahoma Mesonet.

Develop and deliver weather and climate education for the general public, agriculture and natural resource sectors through OSU SUNUP TV, online video/audio tutorials, fact sheets, email newsletters, educational programs, seminars and workshops.

Conduct research and develop weather-based plant biomass models as a tool in ecosystem, rangeland and pasture management adaptation to climate changes.

Investigate and develop weather-related decision tools in the areas of wildland fire management, plant disease prediction, livestock environmental management, and crop heat units as they relate to agronomic crop stage.

Create factsheets, videos and webcontent to explain anaerobic digestion of animal manure to the layman and provide practicing engineers material to aid in design and operation.

Create factsheets, videos and webcontent to physical properties of of byproduct materials to the layman and provide practicing engineers material to aid in design of materials handling and physical treatment equipment.

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, homeowners

3. How was eXtension used?

Josh Payne has uploaded 22 frequently ask questions videos concerning animal mortality composting on the Animal Manure Management resource area. These videos have had 3,500 views. Doug Hamilton has written 4 pages on anaerobic digestion in the Farm Energy resource area. The pages were visited by 2,740 users in 2014, with an average time on page of 4 minutes thirty seconds. OSU is the lead institution on the eXtension controlled burning CoP.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	12030	214616	2007	12000

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

Patent Applications Submitted

Year: 2014
 Actual: 1

Patents listed

Phosphorus Removal Structure

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	28	45	73

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Grant proposals written and submitted

Year	Actual
2014	41

Output #2

Output Measure

- Manuscripts submitted for consideration of peer-reviewed publication

Year	Actual
2014	55

Output #3

Output Measure

- Extension conferences, workshops and training sessions

Year	Actual
2014	99

Output #4

Output Measure

- Research and Extension reports and fact sheets

Year	Actual
2014	33

Output #5

Output Measure

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

Year	Actual
2014	16

Output #6

Output Measure

- Weather-based decision support tools made operational and delivered through Oklahoma Mesonet websites for use on computer and mobile devices.

Year	Actual
2014	1

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	Number of users accessing website designed to deliver information about water policy, conservation and efficient use
5	Number of downloads of Extension fact sheets and related education materials
6	Number of enrollments in conservation-related land management programs
7	Land area restored in Oklahoma through invasive/encroaching species removal
8	Land area restored in Oklahoma through prescribed fire or other practices
9	Access by users of Oklahoma Mesonet computer and mobile device weather and climate data and tools
10	Development of a Particulate Matter Data for Dispersion Model
11	Improving Irrigation Efficiency
12	Developing Management Strategies for Sub-surface Drip Irrigation
13	Solute and Contaminant Transport between Streams and Alluvial Floodplains
14	Improved Chicken Litter Handling and Transport
15	Bird collisions with U.S. buildings
16	Biophysical and hydrological parameterization of eastern redcedar using paired experimental watershed data
17	Carbon Sequestration in Oklahoma Forests and Probable Response to Climate Change

18	Grassland management to benefit wildlife and promote beef production in the Flint Hills - Number of Acres Management Changed
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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

Year	Actual
2014	654

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Oklahoma Register Poultry Feeding Operations Act requires all poultry farmers and litter applicators to attend 9 hours of educational training in the first year of operation, and an additional 2 hours of training annually until a total of 19 hours of training have been earned. Following the initial 19 hours of training, operators and applicators must attend two hours of training every three years. Training must include environmental processes relevant to maintaining water quality, proper manure handling techniques, nutrient management and record keeping, and relevant laws and rules relevant to poultry waste management in the State of Oklahoma.

What has been done

Since 1998, 2,700 people have completed the initial nine hours of required training. In 2014, 55 new producers completed the initial nine hours of training, and 599 completed an additional 2 hours of training. New subject matter developed in 2014 included a new resource manual "Record Keeping for Poultry Litter Applicators" designed to assist applicators with the record keeping process. This comprehensive tool included blank record forms, calculation spreadsheets, maps, regulatory information and nutrient management fact sheets in one easy to use resource.

Results

One hundred percent of initial nine hour attendees surveyed said the information they had learned would help them in their daily operations, with 88% strongly agreeing with the statement. Of 272 surveyed at continuing education classes, over 80% said they had improved waste handling practices, remained in compliance with regulations, and improved the efficiency of their operation as a result of poultry waste management education classes. Seventy-eight percent had

implemented a new technology or practice, and 46% of those surveyed transferred litter out of nutrient sensitive 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
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	75

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Producers are reluctant to adopt new technologies without firsthand experience with the technology. The North American Manure Expo began modestly 12 years ago in Wisconsin as a joint effort between Extension, manure applicators, and the agricultural equipment industry to provide live demonstrations of waste application equipment. The Expo has grown to become a major annual event, travelling to 13 American states and Canadian provinces.

What has been done

The North American Manure Expo travelled south for the first time in 2014, and was held July 8 and 9th in Springfield, Mo. The University of Missouri and Oklahoma Cooperative Extension Services acted as co-educational partners for the Expo. The two day event features live demonstrations of manure agitation equipment, sludge removal dredges, solid waste applicators, liquid manure injectors, as well as, cleaning and disinfection equipment. Fifty-three manure handling, applying and management companies participated in a one and a half day trade show.

Educational classes offered in depth instruction on equipment operation, manure value optimization, new equipment for solid and liquid application, and environmental protection. A special session was held on the manure applicators role in reducing the spread of Porcine Epidemic Diarrhea Virus.

Results

Over six hundred farmers, manure applicators, governmental agency personnel, Extension educators, and journalists attended the 2014 North American Manure Expo. Based on past surveys of Manure Expos, 57% of attendees said it was an important or very important source of information when they make manure application decisions. Ninety-two percent of farmers and applicators used what they learned at the Expo to do a better job of handling manure, and an identical percentage shared information they had gained at the Expo with others. Twenty-two percent of applicators saved money based on information learned at past expos, with average savings of \$6,500 per year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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

Year	Actual
2014	461

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #4

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

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	8780

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Number of downloads of Extension fact sheets and related education materials

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Number of enrollments in conservation-related land management programs

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Land area restored in Oklahoma through invasive/encroaching species removal

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	168000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Oklahoma landscapes evolved with frequent fire and decades of fire suppression have led to multiple problems ranging from loss of productive grazing land to increased water use and wildfire risk from woody encroachment. Many landowners understand the problem and would incorporate prescribed fire into management but they are limited due to liability concerns, lack of training, lack of equipment, and shortage of labor.

What has been done

OSU extension has assisted with forming locally led prescribed burn associations (PBAs). Through the PBA landowners pool labor and equipment to help each other burn, thereby reducing liability and increasing the available labor and equipment at each burn. Landowners enrolled in PBAs are eligible for grants for equipment and training. NREM extension led development of the Oklahoma Prescribed Burn Association to assist PBAs with education, training, funding, and creation of new PBAs. This has also led to the formation of the Alliance of Prescribed Burn Associations with members from OK, TX, KS and NE to improve prescribed fire use and PBAs on a regional level.

Results

There are currently 21 PBAs in OK covering 37 counties with over 400 members. The OK PBAs conducted 303 burns on at least 168,000 acres 2001-2012. OSU extension along with other groups like the Noble Foundation has conducted 10 hands-on training workshops across the state with at least 500 people attendees. The online training has been very successful with 281 people enrolled in the course from over 15 states. We are continually updating the information and trying to make it user friendly to other states. The OK NRCS has adopted it for their basic training for employees and we are working with the NRCS at the national level to make it the introductory training for all NRCS employees. The Prescribed Fire CoP has 68 fire related articles and 58 Frequently Asked Questions on its site. There have been numerous ask the expert questions answered by its members. From this site NREM extension as also developed a Facebook page that has become very popular. NREM extension work with the OPBA has led to many improvements for landowners across the state. The latest include the availability of prescribed fire liability insurance, an FCC license for a statewide radio frequency for use by OPBA and its member PBAs, development of OPBAs website (ok-pba.org), and the purchase of 8 prescribed burn trailers for PBAs. They have safely conducted 1,100 burns on a half million acres in the past 15 years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
104	Protect Soil from Harmful Effects of Natural Elements
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
605	Natural Resource and Environmental Economics

Outcome #8

1. Outcome Measures

Land area restored in Oklahoma through prescribed fire or other practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	168000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rangelands in the U.S. are grazed by beef cattle that are not native to North America. Most parasitic flies of beef cattle also are not native. The horn fly, *Haematobia irritans* (L.), is the most economically damaging and widespread ectoparasite affecting livestock production with a 1991 estimate of annual losses on US pastured cattle production at \$876 million (equal to \$1.46 billion adjusted for inflation in 2012). Effective primary strategies for horn fly control on beef cattle rely on insecticides. In the 1980s, synthetic pyrethroid ear tags began providing season-long control but resistance is currently widespread. Therefore, alternative control strategies are needed for control of the horn fly and other ectoparasites of beef cattle on rangelands and other grazing lands.

What has been done

Ongoing research in Oklahoma and Iowa provided us the opportunity to assess the effect of burning, including patch-burn grazing, on parasitic flies of beef cattle.

Results

Effects of fire varied by location and species of parasitic fly. However, reducing horn fly populations below the economic threshold by managing rangeland with patch-burn grazing could potentially save tens of millions of dollars, in Oklahoma alone. These losses would be attributed only to improving cattle performance from reducing the number of horn flies and from reduced use of insecticide. Other benefits include reduction of other parasitic fly species, ticks, and internal parasites.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity
205	Plant Management Systems
605	Natural Resource and Environmental Economics

Outcome #9

1. Outcome Measures

Access by users of Oklahoma Mesonet computer and mobile device weather and climate data and tools

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	792685

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 act as a risk management tool that can be used to: 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 provides farmers and ranchers weather-based risk management tools and information in a number of formats, including: website for desktop and tablet, iPhone app, Android app, and mobile website for other cellphone platforms.

Weather-based management has been made possible because the Oklahoma Mesonet operates

one of the most data-rich weather networks in the world. Updated weather data are transmitted every 5 minutes from a statewide system of 120 automated weather-monitoring towers. This constant flow of verified, research-quality weather data are used to maintain a wide spectrum of weather and agricultural decision support products made available for computer and mobile devices.

The challenge in implementing weather-based agricultural management includes: providing intuitive decision-support tools, enhancing mobile device information delivery, expanding grower weather knowledge, and simplifying weather data display. These challenges are further complicated by agriculture's need for forecast, current, and climate perspectives in supporting farm and ranch management decisions.

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 online data and models. The Oklahoma Mesonet data has supported various agricultural and ecological research projects. 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. Android and iPhone apps provide 5-minute weather, forecast, and radar information, wherever the user has mobile network access. Ongoing extension/outreach efforts inform growers about available products and introduction to weather-based farm management tools via farm show exhibits, educational presentations, television, web tutorials, and printed materials.

In 2014 efforts focused on expanding crop and livestock producer, agriculture industry professional and extension educator weather education. Educational presentations and National Weather Center tours provided information to a wide variety of agricultural groups, from producers to political leaders.

Working relationships with Kansas State University were organized to develop new extension publications that will provide basic weather and climate information. From an assessment in 2013 and a 2014 survey of extension educators in Oklahoma and Kansas, basic weather and climate information geared to agricultural audiences were identified as priority needs.

The Wheat First Hollow Stem Advisor was brought online in 2014. The Oklahoma Wheat Commission, Oklahoma Wheat Growers Association and the Oklahoma Cattlemen's Association along with Oklahoma Cooperative Extension Service produced a variety of news releases about the Wheat First Hollow Stem Advisor. Media venues included electronic newsletters, traditional newspaper, and television.

Results

The informal feedback from the Oklahoma agricultural community continues to be very complimentary of the Oklahoma Mesonet. Farmers and ranchers turn to the Mesonet to monitor rainfall and soil moisture on a regular basis as they monitor drought conditions that began in 2010. Conservative estimates of lost farm production in Oklahoma due to this drought cycle are over \$3 billion. Crop insurance has covered a portion of these losses.

Producers have noted how they use Mesonet to determine if a far away field received rain or not.

This eliminates lost time, vehicle wear and tear, and wasted fuel. To minimize drift hazard, producers and custom applicators use the Mesonet Drift Risk Advisor.

Monitoring soil temperature has become increasingly important with the dramatic climb in seed costs to avoid seedling damage from cool soils. Soil moisture provides a way to monitor water available for crop production at the beginning of the planting season. Near Willow, OK a producer used 10 and 24-inch soil moisture to decide not to plant dry land cotton. Lack of rain during that growing season would have resulted in a failed cotton crop and no crop revenue to cover planting and crop care expenses.

Growers monitor current and forecast relative humidity to determine good times to bale hay or harvest crops. Hay producers use the Mesonet to monitor humidity changes for hay baling. The Mesonet allows them to monitor the field conditions from home and get more sleep. A rested farmer is a safer farmer.

An estimated 70% of agriculture producers and 90% of industry professionals in Oklahoma are using smartphones. This makes the Mesonet Android and iPhone apps important tools for delivering the latest weather information to those in the agriculture community. Close to 90% of the people we visit with at farm shows ask us to show them how to download the Mesonet apps on to their smartphone or mention they already have the app. Downloads of the Mesonet iPhone app have climbed to over 33,000, since its release in 2011. Android app downloads have reached 7,500, since December 2013.

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 Mr. Hodges has not put a direct value on Oklahoma Mesonet data, he has stated that Mesonet information has helped Oklahoma grain sellers market 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 uses 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 funnel cloud. Mr. Brigham used the radar displayed by Mesonet to track a tornado that formed and direct their crew out of the path of this tornado to a safer location.

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. This estimated value did not include the Mesonet value to livestock producers for that year and only covered 10% of Oklahoma cropland.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
121	Management of Range Resources
123	Management and Sustainability of Forest Resources

132 Weather and Climate
205 Plant Management Systems

Outcome #10

1. Outcome Measures

Development of a Particulate Matter Data for Dispersion Model

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Robust data sets for evaluating and developing particulate matter dispersion models are virtually non-existent. Generally model developers will evaluate new algorithms against other models and not actual data. Particulate matter dispersion models over predict actual concentrations by a factor of 3.5 to 9. For the majority of industries that are permitted based on modeling results, an over prediction by a factor of two is the difference between being in compliance or not.

What has been done

A highly collaborative team led by a researcher in the OSU Biosystems and Agricultural Engineering has conducted stack and ambient particulate matter sampling tests in California, New Mexico, Texas, Missouri and North Carolina. This is the largest single site particulate sampling campaigns ever conducted. During a single sampling campaign 100 to 130 ambient sampling points are strategically placed around the facility -- ten times more than most ambient sampling campaigns previously conducted. In addition to ambient sampling, the research team is developing average emission rate for each of the point sources. The team is actively compiling the enormous dataset and developing plans to conduct the final large scale control release study. Upon completion, this particulate matter data set will be the largest and most complete resource of its kind.

Results

Use of the developed particulate matter data set could be used by model developers to significantly improve the accuracy and precision of dispersion models, which could lead to industry seeing reduced regulatory pressures due to regulatory agencies using models that are

validated against actual data. State implementation plans could be refined as source level indicators will likely change based on modeling results.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management

Outcome #11

1. Outcome Measures

Improving Irrigation Efficiency

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The demands for freshwater resources in Oklahoma continue to grow from agricultural, industrial, and urban sectors. The increase in drought frequency and intensity plus declining surface and groundwater resources pose significant challenges to water managers and decision makers. Irrigated agriculture and urban landscape are two of the largest users of freshwater in the state and have been significantly impacted by water scarcity during the past several years. Southwest Oklahoma is suffering from record droughts and the Lugert-Altus Irrigation District has not been able to deliver any irrigation water since 2012, due to the low water levels at Lake Altus. Producers in Oklahoma Panhandle are in a better shape as they have access to groundwater, but the water levels in Ogallala aquifer has been dropping constantly, reducing irrigation well capacities. With increasing water scarcity, many producers in eastern Oklahoma are also considering the installation of new or expansion of existing irrigation systems to be able to meet the crop water requirement during the peak season.

What has been done

A comprehensive program was initiated to foster the use of advanced sensor-based technologies to improve irrigation efficiencies and minimize water losses. This program involved 550 contact

hours to educate clientele about recent advances in sensor technologies. In addition, numerous in-print, online, and audio/video educational materials were generated. Three demonstration sites were established in cooperation with local producers near cities of Hydro and Martha to showcase the application of different types of soil moisture sensors under different types of irrigation systems (sprinkler and drip). Another site was established at the Cimarron Valley Research Station to demonstrate the potential of this technology for grape irrigation.

Results

Agricultural producers and urban water managers have shown great interest in this program. Those produces who participated in the program speak highly about it and have encouraged their peers to consider this technology. According to one of them, the use of sensors has also created new questions about his land and water management that he has not considered before. Recently I have been approached by several dryland farmers who are interested in using sensor-based technology to improve their operation, as they have seen the benefits of having knowledge about water content in the soil profile. In addition, several horticultural producers have shown interest in this technology and field visits have been scheduled in 2015 to assist them with purchasing, installing, and maintaining the sensors. We are in the process of talking to the state NRCS to offer cost-share for sensor installation as part of the EQIP program.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

Outcome #12

1. Outcome Measures

Developing Management Strategies for Sub-surface Drip Irrigation

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Subsurface Drip Irrigation (SDI) systems offers great opportunities in terms of precision irrigation and fertilizer application, reduced labor costs, and improved water conservation due to minimized deep percolation, surface runoff, and soil evaporation. However, these potential benefits can only be achieved if these systems are managed and maintained properly. Several states have developed guidelines for managing SDI systems, but these guidelines are area-specific as climate, soil, water, and crop conditions have significant variability. The use of SDI systems is increasing in Oklahoma, necessitating the need to develop management strategies that are useful to Oklahoma producers. As SDI systems require large capital investments, failing to develop and implement appropriate management practices will lead into waste of money and natural resources. One area of particular concern in southwest Oklahoma is the risk of increasing soil salinity by changing from surface/sprinkler to SDI.

What has been done

An integrated research/extension program was initiated to develop and test management guidelines for SDI systems. Two management practices were tested at the OSU-Oklahoma Panhandle Research and Extension Center for irrigation amount and drip tape spacing for corn and sorghum. The results of this project are still being processed, but preliminary results show a great potential for conserving irrigation water. The yield of both crops was highly correlated to the level of irrigation application (50%, 75%, and 100%). But the spacing between crop rows and drip tapes did not seem to have a significant impact on the total yield. Crop emergence and rodent damages, two of the most common challenges in using SDI, were not observed at OPREC study. A pilot project was conducted on a cotton field in southwestern Oklahoma using SDI. The results showed that SDI can be very effective at stretching the limited water resources. However, field measurements indicated a considerable increase in soil salinity compared to an adjacent field under center pivot sprinkler system.

Results

An integrated research/extension program was initiated to develop and test management guidelines for SDI systems. Two management practices were tested at the OSU-Oklahoma Panhandle Research and Extension Center for irrigation amount and drip tape spacing for corn and sorghum. The results of this project are still being processed, but preliminary results show a great potential for conserving irrigation water. The yield of both crops was highly correlated to the level of irrigation application (50%, 75%, and 100%). But the spacing between crop rows and drip tapes did not seem to have a significant impact on the total yield. Crop emergence and rodent damages, two of the most common challenges in using SDI, were not observed at OPREC study. A pilot project was conducted on a cotton field in southwestern Oklahoma using SDI. The results showed that SDI can be very effective at stretching the limited water resources. However, field measurements indicated a considerable increase in soil salinity compared to an adjacent field under center pivot sprinkler system.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

Outcome #13

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

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

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, subsurface phosphorus transport could also be a contributing factor in certain conditions with this transport occurring along focused as opposed to diffuse pathways. A growing collection of research indicates that subsurface phosphorus transport can be significant and also that phosphorus from streambanks can be a considerable source of in-stream phosphorus loads in some watersheds. There is also debate regarding the efficiency of filters and filter size requirements. This debate 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.

What has been done

Significant research progress has occurred on quantifying solute and contaminant transport between riparian floodplains and streams. OSU research quantified heterogeneity in infiltration rates at three floodplain sites in the Ozark ecoregion of Oklahoma and Arkansas. Primary research activities included analyzing previously conducted field studies, including plot scale (1 by 1 m and 3 by 3 m) solute injection experiments along with geophysical imaging, on both gravel outcrops and non-gravel outcrops. Laboratory flow through phosphorus sorption experiments were conducted in order to examine the effect of retention time (RT) and inflow phosphorus concentration on phosphorus sorption; this was compared to results of isothermal titration calorimetry (ITC) experiments.. Data from innovative field studies, including plot scale (1 by 1 m, 3 by 3 m, and 10 by 10 m) solute injection experiments along with geophysical imaging, were

analyzed for both gravel outcrops and non-gravel outcrops. Research is also underway to quantify the magnitude of sediment and phosphorus loading from streambank 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. We characterized the distribution of soil phosphorus concentrations in stream banks both with and without implemented riparian protection in the Barren Fork Creek watershed in eastern Oklahoma. Our research team developed a simple empirical regression model to quantify total phosphorus trapping efficiency by a vegetative filter strip based on the hydrologic (infiltration) and sedimentological response of the filter from ten previous studies reported in the literature.

Results

This research has wide reaching implications for how riparian floodplains throughout the world are managed. Estimates of load reductions of sediment and phosphorus by riparian protection will be used explicitly by the Oklahoma Conservation Commission in justifying conservation practices. 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. Eighteen (18) peer-reviewed, technical, and conference proceedings papers were based on this research work this year:

4. Associated Knowledge Areas

KA Code	Knowledge Area
104	Protect Soil from Harmful Effects of Natural Elements
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #14

1. Outcome Measures

Improved Chicken Litter Handling and Transport

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The poultry industry has an economic importance in Eastern Oklahoma, serving as a major source of employment in rural areas and often a more profitable alternative to traditional agricultural enterprises in the region. Most of these poultry operations are concentrated animal feeding operations (CAFOs). Poultry CAFOs are supported by the import of animal feed containing nutrients such as nitrogen (N), phosphorus (P), and potassium (K); these nutrients are then exported from the farm in the form of agricultural products. However, much of the nutrients imported with the feed will remain on the farm in the form of manure. There hence lies a need to reduce litter mass with little monetary and labor inputs for the purpose of reducing litter transport costs and increasing hauling distances.

What has been done

The objectives of this study were to: (i) determine to what degree an alternative litter storage process (composting) designed to promote C degradation would decrease mass and affect litter properties including nutrient concentrations and carbon forms, and; (ii) conduct an economic analysis of this storage process in the context of transporting litter from poultry dense watersheds to areas deficient in soil P.

Results

Our published results suggest that composting chicken litter will reduce its mass by about 20 percent. This is expected to result in a savings of over \$35 million over the next 20 years in subsidies, transportation costs, and reduced fertilizer expenditures. Our on-going research is estimating the impact on energy savings.

Our research on the application of poultry litter to sweet sorghum indicates that litter can be an economically viable substitute for inorganic fertilizers when applied at nutrient equivalent rates. According to our estimates, poultry litter can be profitably shipped up to 100 miles when compared to commercial fertilizer. Moreover, extending the use of poultry litter as a fertilizer source will enable producers to fertilize sweet sorghum, a crop that is usually left non-amended. Poultry litter, when field applied at the optimal rate will provide a per acre impact of \$75 per acre compared to non-amended fields. Helping improve the profitability of sweet sorghum production will have a positive impact on the biofuel industry in Oklahoma by reducing the cost of biofuel stocks. Increasing the off-site use of poultry litter will also provide substantial environmental impacts to Oklahoma by reducing the potential for phosphorus runoff into its waterways.

Our research team has also begun to research the value of drill cuttings and other soil removed from the oil drillings in Oklahoma. Two research projects are currently proposals have been submitted.

Study results revealed that the two organic fertilizers tested in the experiment, BM and SE, are adequate substitutes for chemical fertilizers. No significant difference in corn yield was found between the organic and chemical sources of nutrients, and BM and SE generated higher economic returns than AA. The findings were generally robust across the wide range of prices encountered during the experiment, although neither SE nor BM would not have been as profitable as AA during the cheap energy prices experienced in the late 1990s (1998-2000). Hence, this study is in agreement with previous research that found animal manures to be adequate, and often remunerative, substitutes for chemical sources of N. Site-specific conditions such as weather, animal waste management practices, and soil properties should be considered

before results can be generalized to other locations outside the Oklahoma Panhandle.

4. Associated Knowledge Areas

KA Code	Knowledge Area
104	Protect Soil from Harmful Effects of Natural Elements
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
205	Plant Management Systems

Outcome #15

1. Outcome Measures

Bird collisions with U.S. buildings

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Collisions with buildings and their windows affect hundreds of North American bird species?from backyard birds to those whose migrations span hemispheres. However, no rigorous U.S. estimates of the number of birds killed have been made, and little is known about whether some species are particularly prone to collisions. We conducted a meta-analysis to quantify bird?building collision mortality, to estimate species vulnerability, and to provide a basis for further research.

What has been done

We combined mortality data from 26 previously conducted studies across the continent and estimated 365?988 million U.S. birds die annually from building collisions. We delivered presentations to national and international audiences, including The Canada/Mexico/U.S. Trilateral Committee for Wildlife and Ecosystem Conservation and Management, and professional

society conferences, including plenary presentations. We published the results in the international journal *The Condor: Ornithological Applications*, and the article was selected as "editor's choice" for the issue. We gave media interviews for ~50 outlets in the U.S. and internationally. We also published an accompanying fact sheet: "Best Practices for Studies of Bird-building Collisions" that we distributed to 12 U.S. and Canadian citizen science programs.

Results

The results and impact of this work have been far-reaching. For example, the USFWS is using our findings to inform broad prioritizing decisions and suggest policies for management of incidental take. Our work was included in the *State of the Birds 2014*, an annual national report published by a consortium of 23 federal agencies and conservation organizations. Officials from county and municipal governments (e.g., San Jose and San Francisco, CA, and Cook County, IL) used our results for "bird-friendly building" guidelines in their jurisdictions. As measured by Altmetric, the paper is #1 all-time for the journal in media coverage and in the top 1% of all research articles ever tracked in any academic field. Our research has reached millions through national and international coverage, including by the BBC, Wall Street Journal, New York Times, Washington Post, USA Today, Nature Magazine, National Geographic, Smithsonian.com, and National Audubon, etc. Our recommended best practices have been adopted by citizen science programs in the U.S. and Canada.

4. Associated Knowledge Areas

KA Code	Knowledge Area
136	Conservation of Biological Diversity

Outcome #16

1. Outcome Measures

Biophysical and hydrological parameterization of eastern redcedar using paired experimental watershed data

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Field studies have confirmed that woody encroachment decreases water yield and availability, however, the quantities could be substantially different across spatial scales. Modeling of encroachment is necessary for upscaling the impact from tree, stand, plot, and experimental watersheds to landscapes. However, representative biophysical and hydrological parameters of juniper species such as eastern redcedar (*Juniperus virginiana* hereafter ?juniper?) for modeling are lacking due to limited data availability and inappropriate experimentation design in previous studies.

What has been done

OSU researchers parameterized the physically-based hydrological transport model, Soil and Water Assessment Tool (SWAT), by using comprehensive in situ observations at three paired experimental watersheds of juniper and grassland at the Cross Timbers Experimental Range (CTER). The watersheds provided accurate water balance control with respect to the rainfall, runoff and soil water storage variations. The recently developed shuffled complexes with principal component analysis algorithm was used to search the best biophysical and hydrological parameters of the juniper within the measured potential parameter ranges.

Results

The calibrated SWAT model successfully reproduced the consistently low soil moisture and surface runoff from juniper encroached watersheds during the 3-year monitoring period (2011-2013). Modeling results suggested a strong climate dependency of water used difference between the grassland and juniper watersheds. On average, evapotranspiration (ET) from the juniper watersheds was annually 100 mm greater than from the grassland. The calibrated SWAT model adequately simulated the long-term streamflow of a nearby, large watershed under rapid eastern redcedar encroachment since 1970. To our knowledge, this is the first complete set of biophysical and hydrological parameters for juniper species. Results from this improved model simulation can provide actionable recommendation for climate change adaptation and mitigation at landscape and river basin scales.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
121	Management of Range Resources

Outcome #17

1. Outcome Measures

Carbon Sequestration in Oklahoma Forests and Probable Response to Climate Change

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Significant amounts of atmospheric carbon are stored in forest resources. Much of this carbon would have otherwise been released to the atmosphere with potentially deleterious effects regarding global warming. Carbon storage is not necessarily incompatible with production of forest products from Oklahoma forests because significant amounts of carbon are often stored long term in forest products. Better methods of quantifying present states of Oklahoma forests and predicting their future states are needed.

What has been done

In cooperation with the USDA Forest Service the 25th year re-measurement of forest growth plots located in shortleaf pine forests in eastern Oklahoma and western Arkansas was completed. These data can be used to model forest growth for a key forest type in eastern Oklahoma. Additionally, several projects relating to improved methods for sampling forests in Oklahoma and the USA more generally were conducted, some of which were cooperative with the USDA forest service.

Results

Two publications were published in international peer reviewed journals relating to improved forest sampling methods. Four additional publications were accepted for publication in international peer-reviewed journals but will be published in 2015. Two presentations were made at national conferences relating to forest measurements. Graduate students constructed forest growth and mortality models using a long-term shortleaf pine remeasurement dataset. This work will be developed for publication and dissemination in 2015. Four abstracts were accepted for poster presentations to be made at the 18th Biennial Southern Silviculture Conference in 2015 in Knoxville, TN.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
141	Air Resource Protection and Management

Outcome #18

1. Outcome Measures

Grassland management to benefit wildlife and promote beef production in the Flint Hills - Number of Acres Management Changed

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	200000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Flint Hills is the largest remaining landscape of Tallgrass Prairie in North America. It is critical habitat for many grassland obligate species. Further, it is highly productive rangeland for beef cattle. Current agricultural practices of annual burning and herbicide use are not conducive for many imperiled species including the greater prairie-chicken (*Tympanuchus cupido*).

What has been done

Our goal is to find productive land management options for livestock producers that reduce cost, maintain or improve livestock production, and improve habitat conditions for grassland obligates including the greater prairie-chicken. We have carried out 5 years of research and outreach on livestock production, prescribed fire, herbicide, vegetation response, public perception, and wildlife response.

Results

We have found that wildlife compatible practices can be carried out without any loss of livestock production. This work has resulted in 8 publications, 2 PhDs, 1 post doc, and 1 research associate. Further this research has directly led to changed management on over 200,000 private acres of the Flint Hills to benefit the greater prairie-chicken and other wildlife while maintaining profitability of livestock producers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources

135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

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

This research has wide reaching implications for how riparian floodplains throughout the world are managed. Estimates of load reductions of sediment and phosphorus by riparian protection will be used explicitly by the Oklahoma Conservation Commission in justifying conservation practices. 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. Eighteen (18) peer-reviewed, technical, and conference proceedings papers were based on this research work this year:

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Feedback from Oklahoma Mesonet users about agriculture and natural resource decision support products has been positive. Users have expressed high approval of Mesonet iPhone and Android apps. Long-time users note how they learn something new each time they go to another workshop or seminar. This indicates the depth of the weather information and decision support products made operational by the Oklahoma Mesonet. It provides informal verification that learning about and incorporating weather data and information into the management process is a long-term process. The Poultry Litter Educational Program surveyed participants of educational programs. One hundred percent of initial nine hour attendees surveyed said the information they had learned would help them in their daily operations, with 88% strongly agreeing with the statement. Of 272 surveyed at continuing education classes, over 80% said they had improved waste handling practices, remained in compliance with regulations, and improved the efficiency of their operation as a result of poultry waste management education classes. Seventy-eight percent had implemented a new technology or practice, and 46% of those surveyed transferred litter out of nutrient sensitive watersheds.

Key Items of Evaluation

Key Items of Evaluation:

Feedback on OK-FIRE website information and decision support products.
Feedback on Oklahoma Mesonet website weather data and information.
Feedback on Oklahoma Mesonet Agriculture section decision support products.