V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Climate Change

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
132	Weather and Climate	50%		10%	
133	Pollution Prevention and Mitigation	40%		40%	
605	Natural Resource and Environmental Economics	10%		50%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	2.0	0.0	1.0	0.0
Actual Paid Professional	4.0	0.0	0.9	0.0
Actual Volunteer	5.0	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**
231713	0	118745	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
231713	0	142934	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

On-going research activities related to climate change include both basic and applied research. This research takes place in all academic programs within the College of Food, Agricultural, and Environmental Sciences. Laboratory-based experiments, pilot plants, a feedstock processing plant, greenhouses, and research plots and stations support this program. All functional laboratories and sites are improved over time as program need warrants. OSU Extension provides parallel programs in this Planned Program to advance knowledge, promote adoption and change, and develop human capital. OARDC and OSU Extension faculty and staff engage in appropriate levels of outreach, engagement, and consultation, with both internal and external stakeholders.

2. Brief description of the target audience

In the Climate Change Planned Program, targeted audiences include, but are not limited to:

- Businesses and industries that have expressed a need for climate change information that is derived through new research, extracted from on-going research, or is derived from scientific literature;
- Fellow academic units that partner with program scientists to create systems and processes needed to support not only the research, but also the adoption of the research findings by industrial partners;
- Fellow agencies or support organizations who will not only use the information but will also be brokers of that information, including embedding it into groups to encourage change;
- Populations who have not requested the information but will likely benefit from that information (those in the general public)
- Other scientists and scientific groups;
- Political entities;
- Other education, outreach, and extension personnel;
- Students, from elementary school to post-doctorate studies;
- News organizations.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2759	14000	0	1145

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
Actual	3	12	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Graduate Students Completed
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of participants attending educational programs of one teaching hour or more.

Year	Actual
2012	2759

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Advance the understanding of soil carbon sequestration research to the point that Ohio farmers can enter the carbon trading market.
2	Create strategies/technologies within our program mission to reduce atmospheric pollution that can contribute to global climate change.
3	Number of producers adopting methane recovery systems.
4	Number of animal units affected by methane recovery systems.
5	Number of producers using no-till techniques to sequester carbon in the soil.
6	2. Create strategies/technologies within our program mission to reduce atmospheric pollution that can contribute to global climate change
7	number of strategies / technologies created within our program mission to reduce atmospheric pollution that can contribute to global climate change (OSUE)

Outcome #1

1. Outcome Measures

Advance the understanding of soil carbon sequestration research to the point that Ohio farmers can enter the carbon trading market.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Create strategies/technologies within our program mission to reduce atmospheric pollution that can contribute to global climate change.

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)
Agricultural scientists are seeking ways to improve the efficiency of food animal digestion and nutrient capture by the animal. This improvement needs to enhance environmental quality, as well as animal productivity and profitability. Emissions from food animals are considered a major issue in managing air quality and are a contributor to climate change. Globally, livestock are the largest source of methane from human-related activities, and are the third-largest source of this greenhouse gas in the United States, according to the United States EPA.

What has been done
OARDC efforts have isolated a bacterium (WG-1)from the gut of Australian Tamma wallabies that allows wallabies to consume and digest grasses, leaves, and other plant material without producing copious amounts of methane, as cattle do. This was determined by using a partial reconstruction of the bacterium's metabolism (nitrogen and carbohydrate utilization pathways and antibiotic resistance) to devise cultivation-based strategies that produced axenic WG-1 cultures. Research showed that methane emissions from Tammar wallabies amount to 1-2% of their digestible energy intake, compared roughly 10% in sheep.

Results
The Australian Tammar wallaby (Macropus eugenii) harbors a unique gut bacterium that produces only one-fifth the amount of methane produced by ruminants per unit of digestible energy intake. The scientists have isolated a dominant bacterial species (WG-1) from the wallaby microbiota that is related to lower methane emissions from starch-containing diets. This was achieved by using a partial reconstruction of the bacterium?s metabolism (nitrogen and carbohydrate utilization pathways and antibiotic resistance) to devise cultivation-based strategies that produced axenic WG-1 cultures. Pure-culture studies confirm that the bacterium is capnophilic and produces succinate, further explaining a microbiological basis for lower methane emissions from macropodids. This knowledge provides new strategic targets for redirecting fermentation and reducing methane production in livestock.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
133	Pollution Prevention and Mitigation

Outcome #3

1. Outcome Measures

Number of producers adopting methane recovery systems.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of animal units affected by methane recovery systems.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Number of producers using no-till techniques to sequester carbon in the soil.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	5000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Ohio farmers face many challenges including soil erosion, nutrient runoff, harmful algae blooms, soil compaction, and pest control. OSU Extension provides soil quality and health training on cover crops to enable Ohio farmers to protect and improve their soil for higher crop yields and increased farm profitability. Cover crops improve water infiltration, reduce nutrient runoff, absorb and recycle soluble crop nutrients which reduce waste, decrease soil compaction, and improve drainage.

What has been done
Multiple meetings on no-till techniques were conducted throughout 2012. Additionally, a Conservation Tillage Conference was held, where multiple break-out sessions were offered on no-till techniques. Conference attendance exceeded 900 producers.

Results
Meeting and conference participants indicated increased awareness on soil quality motivations, greater adaptation of sustainable practices to improve soil quality and increased farm income.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

<u>Outcome #6</u>

1. Outcome Measures

2. Create strategies/technologies within our program mission to reduce atmospheric pollution that can contribute to global climate change

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)
Livestock operations are estimated to cause about 50, 25, and 18% of ammonia, nitrous oxide, and methane emissions, respectively, in the United States. Ammonia reduces air quality, and nitrous oxide and methane are 310 and 25 times more potent, respectfully, than carbon dioxide for global warming potential. Dairy cattle present a strong opportunity for reducing emissions because the rumen microbial ecosystem creates a highly variable environment for ammonia and methane production. Manure nitrogen excretion is inevitable, but ?extra? excretion results from inefficiencies of ruminal fermentative processes. A strategy for methane mitigation is needed.

What has been done
OARDC scientists studied these inefficiencies while retaining safety factors of higher dietary protein needed to prevent depressions of feed intake and milk production by dairy cows. Culture and chemotaxis studies document that protozoal growth rate responds rapidly to dietary conditions, passage rate from the rumen, and substrate supply. Even when protozoa grow less efficiently, they are still produce ATP but are wasting that energy through biochemical pathways. Therefore, even when growing inefficiently or being exposed to inhibitors, protozoa still produce high amounts of hydrogen gas to fuel methanogenesis.

Results
An integrated methane mitigation approach can reduce methane emission from cattle. Reliably reducing dietary crude protein by 0.5% or improving fiber digestibility by 5% could save up to $30 to $40 per cow per year in feed costs. If these strategies are successful even for 10% of Ohio's 280,000 cows, savings in feed costs should provide approximately $7 million dollars to Ohio's annual economy while sustainably reducing environmental impact.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

Outcome #7

1. Outcome Measures

number of strategies / technologies created within our program mission to reduce atmospheric pollution that can contribute to global climate change (OSUE)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change and its related impacts affect many factors that influence the daily lives of the general public, such as infrastructure, public health, agriculture, and water quality. Yet very few understand what impacts they could face from a state or Great Lakes regional perspective.

What has been done
OSU Extension produced 10 webinars reaching 2,650 participants and representing 200+ organizations, with another 150 people downloading webinars every month. A climate change website was developed (http://changingclimate.osu.edu); the site includes webinar archives and climate curricula. Extension professionals created a climate change curriculum training webinar that introduced 109 teachers across the region to new climate curriculum. Additionally, Extension professionals conducted a "Sustainable Water Resources & Climate Change Short Course", and developed 2 distance education programs.

Results
93% of webinar participants acknowledge they gained new information and would share it with others. 71% of respondents from one webinar indicated they learned something new that they would apply in their work or future decisions. In the after-course evaluation survey of the "Sustainable Water Resources & Climate Change Short Course", 90% of participants indicated they felt equipped to apply sustainability principles to water resources and climate change planning in their community, compared to pre-course evaluation results of the same question that indicated only 21% of participants feeling equipped.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Other (Social Acceptance of the Issue)

Brief Explanation

Climate change is a multi-dimensional, political, and socially debated topic, thus a shift in any or all of the above dimensions affect outcomes. Perhaps more impacting than any other dimension is the continuing erratic nature of weather patterns. We see examples of erratic weather patterns in the droughts experienced in Ohio, most of the Midwest, and Texas in 2012. Flooding and other highly irregular weather patterns also impacted the United States in 2012.

These errata will confound changes in public policy and environmental regulations, cause demands for action / inaction, and necessitate the creation of new weather predictive models.

Internal factors such as the availability of base funding to ensure a core faculty and staff, availability of extramural funds, availability of competitive funds, and programmatic demands that often exceed resources, also may affect outcomes. All of these climactic, public, and policy changes will be further compounded by a lack of worldwide consensus on how to respond, react and lead in the arena of climate change.

While we have no data that points to climate change as the cause, we do know the losses that can be attributed to weather factors for research projects and to production losses throughout the state.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Researchers and Extension personnel have worked with stakeholders to gather the most relevant data regarding variations in productivity, pest damage, drought or excess water; all of which are impacted by climate change. Based upon this data, personnel from the College of Food, Agriculture, and Environmental Sciences have sought to find strategies to mitigate impacts.

Evaluation results of OSU Extension programming in no-till methods and cover crop use shows that each year the number of acres of cover crops planted has been doubling and tripling in number. For example, in Mercer County alone, farmers planted 3,400 acres of cover cops in 2012. 17% of Mercer County crop land is now planted in cover crops annually, with the nationwide average estimated to be only 3% to 5%. 16% of farmers

surveyed reported more consistent crop yields during wet and dry weather periods due to cover crops. Evaluation results of Climate Change-related programming shows 93% of webinar participants acknowledge they gained new information and would share it. 71% of respondents from one webinar learned something new that they would apply in their work or future decisions. In the after-course evaluation survey of the "Sustainable Water Resources & Climate Change Short Course", 90% of participants indicated they felt equipped to apply sustainability principles to water resources and climate change planning in their community, compared to pre-course evaluation results of the same question that indicated only 21% of participants feeling equipped. Evaluation results from Extension programming on topics related to the planned program of "Climate Change" all show positive gains in knowledge and intended behavior changes.

Key Items of Evaluation

Perhaps one of the key examples of feedback being received relates to the monitoring and response to soybean rust. This year, Ohio Agricultural Research and Development Center (OARDC) is one of the recipients of the 2012 Experiment Station Section Award of Excellence in Multistate Research for its work to rapidly address the threat of soybean rust to U.S. agricultural production. OSU Extension is a critical part of the network receiving this National Institute of Food and Agriculture (NIFA) and the Association of Public and Land-grant Universities (APLU) award in recognition of successful, well-coordinated, high-impact, multi-institution research efforts.

OARDC scientists earned the award along with colleagues from more than 30 U.S. and Canadian land-grant universities, federal agencies and industry associations involved in the project, officially called NCERA-208 (North Central Extension and Research Activity), "Response to Emerging Soybean Rust Threat." The award recognizes the fact that a multistate research network enables the land-grant colleges of agriculture to rapidly mobilize to meet and address research needs on emerging threats, as well as to coordinate research activities on priority regional and national topics.

NCERA-208 has identified management strategies for soybean rust, a fungal disease that poses a serious threat to soybean production. First detected in the U.S. in 2004, soybean rust has caused serious concern due to high yield losses from the disease, as experienced in South America. Since then, it has spread through the southern and midwestern U.S., with some states experiencing severe yield losses in isolated areas.

Among many accomplishments, the NCERA-208 team has closely tracked the disease using an extensive network initially of over 2,300 "sentinel plots," helping farmers know more precisely where the disease is likely to occur and when and what types of fungicides to use. Timely, accurate information has greatly reduced the amount of fungicide used by growers, saving the soybean industry hundreds of millions of dollars and reducing human and environmental health.