

V(A). Planned Program (Summary)

Program # 3

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
102	Soil, Plant, Water, Nutrient Relationships	50%		20%	
123	Management and Sustainability of Forest Resources	0%		30%	
132	Weather and Climate	50%		20%	
605	Natural Resource and Environmental Economics	0%		30%	
	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	0.0	0.0	41.9	0.0
Actual Paid Professional	0.0	0.0	13.5	0.0
Actual Volunteer	0.0	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
0	0	53407	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	708053	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1285659	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

MAES. In 2012, for the second time in state history, some counties in Minnesota had federal disaster declarations made for drought, while at the same time, others had disaster declarations for flooding. The documented change in Minnesota's climate has created more volatile weather, and more localized extreme weather events. Minnesota has seen increases in intense thunderstorm rains, flash floods, spring snowmelt floods, large hail, tornadoes and heat advisories. Climate change has had impact on Minnesota's forests, crops, and economic stability. MAES research in 2012 documented some of those impacts, as well as investigated mitigation options.

The efforts of both MAES research and Extension outreach efforts culminated in a presentation to a joint meeting of three Minnesota State House Committees to discuss implications to Minnesota of climate change. At the meeting, our Extension climatologist said that changes in temperature, dew points and moisture levels have implications of severe weather, and that Minnesota climate is changing in significant ways. Minnesota saw its warmest year on record in 2012. U of M researchers explained that dramatic changes in the state's natural environment have begun and are expected to continue unless carbon dioxide levels in the world are reduced.

As a result, farmers who in the past worked to remove excess water from their fields may soon need to deploy water conservation tactics. Forest management may involve introducing desirable species of trees to get ahead of invasive less-desirable varieties. University research and outreach is helping to guide those decisions.

As the MAES forestry researcher told the House committees, " Scientists may still be debating the magnitude of the changes that are coming, but they do not disagree about the direction of the trend line."

Some specific example of MAES research outcomes in 2012:

- The MAES supported Southwest Research and Outreach Center is one of the partners in a five-year U.S.D.A. funded Sustainable Corn Project. The goal of the research is to make predictions about climate change and corn production. Models predict more extreme precipitation in the spring, more extended periods of dryness in summer, and that more moisture in the air will actually hold down temperatures in the summer but lead to higher temperatures at night which tend to reduce corn yield. The combined research and Extension project is providing corn growers with information on how to adapt their practices to weather patterns they haven't seen before.
- Minnesota's greenhouse-gas emissions could be reduced through the development of biofuels. Researchers are investigating a new type of crop called penny crest grass that farmers could plant after harvesting soybeans. It holds water and soil on the land, provides critical forage for bees, and could boost profits by \$300 per acre.
- Forestry research has shown that though it's impossible to predict how or how quickly Minnesota's northern forests will change, it could be possible to move in warmer-species trees, native to places like Iowa, to establish a different but more resilient forest.
- Other forestry research has shown that large-scale forest diebacks, like those that afflicted large birch stands along the North Shore two summers ago, will continue. Eventually the canoe country forests of spruce, fir and jack pine will yield to red maples and hardwoods where soils are deep enough, and savannahs of grassland and oak where the soil is shallow and sandy. Forest research indicates that it's possible that before the end of this century the border between prairie and what we now think of as the north woods may shift northward by as much as 300 miles in Minnesota and other states at our latitude.

Other climate change research impacts in 2012 related to agricultural output and the carbon sequestration potential of northern Minnesota forests are described in the Outcomes section.

The **Extension** Climate Change initiative is a multi-disciplinary program mobilizing available Extension programming and research, with FTEs allocated in areas such as forestry, environmental science education, water, crops, horticulture and more. While FTEs are not formally aligned with the Climate Change program area, joint outcomes and outputs will be described here in order to track our progress toward the NIFA priority area.

2. Brief description of the target audience

Targeted audiences for both MAES research and Extension programming are those with whom we can make a difference, and who can benefit from research-based information. Many are those audiences targeted by other program areas, as described in those plans of work. Primarily, these include audiences whose production systems will be influenced by climate change, as well as those who consult or influence the decision-makers of these growers and producers. Other audiences to be considered will be decision-makers and leaders responsible for preparing communities for change. This includes local government jurisdictions, state and local elected officials, producers and environmental groups, forestry groups, human health services, FEMA, and Extension educators working in food and nutrition, family and community life issues. It also includes other researchers in agriculture, forestry and natural resources, climate scientists, biologists and climate change policymakers.

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	0	0	0	0

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	2	18	20

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A multi-disciplinary Community of Practice among researchers and Extension educators will effectively gather and interpret science-based knowledge about the implications of climate variability for production systems, natural resource systems and others. (Target expressed as number of Extension educators and specialist engaged in the Community of Practice.)
Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Presentations will reach practitioners who need to integrate information about climate change into their program content. (Target expressed as the number of presentations each year.)
Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Recommendations and guidelines for climate change adaptation will be developed, maintained and integrated into Extension's educational programs. (Target expressed as number of Extension educational offerings that have integrated climate adaptation plans into curriculum or program plans.)
Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Outcome target measures will be developed as a result of consultation with stakeholders, educators, researchers, literature review and program best practices. (Target expressed as number of action and condition goals to be articulated throughout program development.)
2	Research will determine the capacity of plants to absorb more carbon dioxide to help offset increases in atmospheric carbon.
3	Research will provide information on the effects of climate and land use changes on Midwest U.S. agro-ecosystems
4	Research will provide tools and information about the dynamics of Minnesota's climate system, for science and for education.

Outcome #1

1. Outcome Measures

Outcome target measures will be developed as a result of consultation with stakeholders, educators, researchers, literature review and program best practices. (Target expressed as number of action and condition goals to be articulated throughout program development.)

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Research will determine the capacity of plants to absorb more carbon dioxide to help offset increases in atmospheric carbon.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2012

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

As carbon dioxide levels in the atmosphere continue to climb, most climate models project that the world's oceans and trees will keep soaking up more than half of the extra carbon dioxide. Because plants take up carbon dioxide during photosynthesis, it has long been assumed that they will provide a large carbon "sink" to help offset increases in atmospheric carbon dioxide caused by the burning of fossil fuel.

What has been done

In a 13-year field experiment on 296 open-air plots, which concluded in 2012, researchers grew perennial grassland species under ambient and elevated concentrations of both atmospheric carbon dioxide and soil nitrogen. As the MAES forest researcher explained, "Rather than building a time machine and comparing how ecosystems behave in 2070, we basically created the atmosphere of 2070 above our plots."

Results

The research showed that grasses growing under heightened carbon dioxide levels grew only half as much in untreated as in enriched nitrogen soil. They grow less under elevated carbon

conditions owing to limitations in soil nutrients. The simulations predicted that land plants will absorb 23 percent less carbon than is projected by other models. This was the first study that addressed a question that has been out there for decades. The study showed that plants' carbon-sinking capacity is much lower than thought.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate

Outcome #3

1. Outcome Measures

Research will provide information on the effects of climate and land use changes on Midwest U.S. agro-ecosystems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2012

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Midwest U.S. is one of the world's most agriculturally dedicated areas, with soybean, corn and wheat being produced on nearly 35 percent of the total land area. Future effects of climate change on ecosystems will be dominated by the response of those crops, and will significantly contribute to the overall feedback of the U.S. biosphere on the atmosphere.

What has been done

Research has been conducted to correctly reproduce the simulated response of soybean to elevated ozone concentrations. Simulations were also performed to predict how changes in climate might affect corn and wheat crops. Researchers also performed test simulations of the Agro-IBIS model for different corn practices cross the Midwestern U.S. using a new high resolution climate dataset.

Results

This novel work has provided new understanding of how agro-ecosystems respond to environmental change at a regional scale. Researchers found that output from global climate

models must be downscaled in order to accurately simulate crop yields, and that crop yields in Iowa and Australia might be dramatically lowered in the future from increased climate variability. Also, this work has contributed to bringing water use into discussions on future land use, whereas until now most of the discussion has been on sustaining yields and quantifying biomass for bioenergy.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate

Outcome #4

1. Outcome Measures

Research will provide tools and information about the dynamics of Minnesota's climate system, for science and for education.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2012

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

To understand the actual impacts of climate and land use change in Minnesota, both more data and better methodologies for in situ field measurements need to be developed and refined.

What has been done

Trace gas monitoring networks that characterize the variability of carbon dioxide, nitrous oxide, methane and water vapor have been established in the MAES Research and Outreach system. A key feature of the network is a 244 meter tower, located at one of them, which provides a regional perspective of greenhouse gas concentrations.

Results

In 2012, the research made significant contributions to understanding the greenhouse gas budget of agricultural ecosystems typical of the Upper Midwestern U.S. Researchers have also developed a database tool that allows students to explore the large datasets/databases and

broaden their understanding of atmospheric science. The tool developed by the researcher has now been made publicly available.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Other (Degree of climate change)

Brief Explanation

The main external factor that had an impact on MAES and Extension work on the issue of climate change was the increased visibility and heightened awareness of this issue among agricultural and forestry producers, natural resource managers, public policy makers and the general public due to dramatic Minnesota weather in 2012. The fact that by the end of the year more than 80 percent of the state was in severe or extreme drought focused attention on our climate change research and education. The results of the research itself provided information to broaden the scope of other research projects, and to take a more systems-approach to the issue.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}