

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	20%		20%	
104	Protect Soil from Harmful Effects of Natural Elements	20%		10%	
123	Management and Sustainability of Forest Resources	20%		30%	
132	Weather and Climate	20%		20%	
605	Natural Resource and Environmental Economics	20%		20%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	25.7	0.0
Actual Paid Professional	0.0	0.0	13.3	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	148214	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	540319	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1314667	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

MAES. In 2013 five U of M researchers testified before a joint committee hearing in the Minnesota House of Representatives about the climate change before us, and how current science can help inform investment decisions. Much of this research is and has been supported by MAES funding. MAES research expertise ranges from climatology to forestry to water resources and agricultural products. Much of it is broad-based and interdisciplinary. Research has focused on three areas: building understanding on what is happening to our climate; mitigation--discovering ways to prevent the warming from getting significantly worse in the future; and adaptation--building resilience into forest and agricultural systems so they are less susceptible to disruption by changing climate. Results of research in 2013 include:

- Forest researchers have concluded that it appears very likely that spruce, fir and aspen forests will move north into Canada over the next several decades as the state warms.
- Other forest research has shown that afforestation and reforestation for the purposes of climate change mitigation is likely not possible because the biophysical impacts of forests far outweigh the carbon sequestration benefits of most forests. While there are small regions where forest placement can provide a climate benefit, these areas only make a small dent in the overall carbon reduction necessary to stave off significant climate change. Researchers are now focusing on management practices that can be adopted for a given location to minimize those biophysical impacts. Researchers refined a numerical model to simulate the climatic effect of forest placement and have used the model to identify the regions where afforestation for carbon sequestration can be successful to benefit the climate system.
- Six years ago MAES researchers established trace gas monitoring networks at the Research and Outreach centers across the state to track the spatial and temporal variability of carbon dioxide, nitrous oxide, methane, and water vapor. A key feature of the network is a 244m tall tower located at one of the centers that provides a regional perspective of greenhouse gas concentration. The recently completed analysis of the project summarized the significant contributions to understanding the greenhouse gas budget of agricultural ecosystems typical of the Upper Midwest.
- Climate change is stressing plants and bringing new pests and diseases into Minnesota. Japanese beetles were seen in fields two months earlier than previously, causing more defoliation in soybean fields, for example. Warm and wet field conditions also increase the risk of phytophthora rot. Researchers are studying new seed treatment fungicides and biological seed treatments to meet the new pressures in agricultural fields resulting from climate change.
- Horticulturists are improving "fine fescues" grasses to develop more sustainable and drought-resistant turf grasses, both for home lawns and public spaces. The fine fescues also need require less effort and inputs to maintain.
- A climate trend analysis on the effect of climate change on the productivity of barley and oats in Minnesota was completed and showed that climate change has already had an effect on the productivity of both barley and oats. It predicted future changes will even further reduce yield potential for barley and oats in Minnesota. Wheat and barley breeders are focusing on creating new varieties that will better tolerate Minnesota's climate trends.
- A team of researchers studying plants assembled the largest dated evolutionary tree, using it to show the order in which flowering plants evolved specific strategies, such as the seasonal shedding of leaves. Their conclusions were publishing in the journal Nature in 2013. The research shows the whens, hows and whys behind plant species' trait evolution and movements around the globe. The information will help build better models of what's going to happen with vegetation in the future as the climate changes.

Extension. Extension's Climate Change initiative is a multi-disciplinary approach, mobilizing

relevant Extension programming and research that address climate change adaptation. Extension and research teams involved in the climate change initiative include forestry, environmental science education, water, crops, horticulture and more. While Extension FTEs are not formally aligned with the Climate Change program area, outcomes and outputs will be described here in order to track Extension's progress in addressing the NIFA priority area.

The year 2013 was a bellweather year for this initiative, because three initiative activities were enthusiastically embraced by stakeholders in Extension, the University, Minnesota and beyond.

1. On November, 2013, Extension hosted a state conference on climate adaptation and received an enthusiastic response. The conference exceeded expectations regarding registration, ultimately turning potential registrants away after attracting 250 participants. Evaluations demonstrated that this conference filled a gap for bringing education and discussion to those who want to find successful climate adaptation strategies for Minnesota's economy, communities, and residents. The conference generated significant popular press, and will become an annual event.

2. Program leaders initiated a sustained effort to train and deploy statewide phenology volunteers who are now monitoring key climate indicators. Thirty-seven (37) volunteers were recruited and trained in 2013. Over the next decade, this effort should result in data that is useful to decision-makers throughout the region regarding climate change rates/amplitudes.

3. Extension staff and national colleagues are now confident that climate change adaptation is an issue that is ripe for more active educational offerings in Minnesota.

2. Brief description of the target audience

In 2013, effective outreach drew together a large group of Minnesotans who expressed a desire to receive education and address adaptation issues in their homes, communities and disciplines. Of the over 250 persons who participated in the November 7th climate change conference, most worked in government (60 percent); one in five worked in education (18 percent), and one in ten worked in non-profit organizations.

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. 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 decisionmakers 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. 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

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	277	4764	0	0

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

Patent Applications Submitted

Year: 2013
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	23	23

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of current year climate relevant educational program offerings.

Year	Actual
2013	14

Output #2

Output Measure

- Number of climate relevant social media products, web-based products and communication tools (smart phone apps, facebook, twitter).

Year	Actual
2013	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Of program participants, the number that increase knowledge of management practices under climate variability and change.
2	Of participants, the number that employ climate adaptation strategies in various production and natural ecosystems, including strategies for biodiversity.
3	Number of acres under recommended adoption strategies for production agriculture and natural resources management, including invasive species, pest management, pollutant loads and wetlands.
4	Of participants, the number that adopted recommended adaptation strategies for production agriculture and natural resources management, including invasive species, pest management, pollutant loads, wetlands.
5	Research will develop new knowledge and technologies related to climate change. (Measure: number of new crop varieties and genotypes with climate adaptive traits; number of new assessment and management tools developed, including models and measurements; number of new climate relevant databases, monitoring systems and inventories managed or under development)
6	Volunteers are mobilized to actively monitor seven key indicator species to examine climate variability. (Outcome is the number of volunteers who are engaged in reporting data to a web portal.)

Outcome #1

1. Outcome Measures

Of program participants, the number that increase knowledge of management practices under climate variability and change.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	90

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

As climate changes, a growing group of concerned citizens and professionals are eager to move beyond controversy to address how to adapt and prepare for the effects of climate change on individuals, economies, and communities.

What has been done

Minnesota's first climate change conference was conducted on November 7, 2013. The event exceeded expectations regarding interest. Twelve presentations were offered on a diverse group of topics that presented information about climate change and ideas for adaptation -- urban ecosystems, stormwater, water quality, extreme events, as well as public health, agriculture, highways, community water, and Twin Cities issues.

Results

For each of the twelve sessions, participants "agreed" or "strongly agreed" that the session gave new information. More importantly, a strong majority of those who were in a position to act reported that the information they received gave them ideas for further action (90 percent or more).

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
123	Management and Sustainability of Forest Resources
132	Weather and Climate

605 Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

Of participants, the number that employ climate adaptation strategies in various production and natural ecosystems, including strategies for biodiversity.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Number of acres under recommended adoption strategies for production agriculture and natural resources management, including invasive species, pest management, pollutant loads and wetlands.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Minnesota's forest, land, and water resources face pressure from climate change. Geospatial science, including remote sensing and geographic information systems, provides a useful set of tools with which to characterize and detect changes in landscape. Mapping Minnesota's resources and monitoring potential negative effects is of critical importance to retaining their presence and function for future generations.

What has been done

Researchers have developed multiple methods to map wetlands using both imagery and other geospatial data showing the changing likelihood of an area being a wetland over time. These new ways of viewing the temporal dynamics of wetlands allow for much more sophisticated management decision-making than is possible with a map based on a single time, such as the widely used National Wetlands Inventory. The results of this research have been incorporated into the ongoing creation of an updated wetlands inventory for Minnesota

Results

The improved mapping techniques resulting from this work are being used by wetland mapping teams, which is resulting in significantly better accuracy estimates than with previous methods. The ability to map and monitor wetlands more quickly and accurately is allowing stakeholders to make more informed decisions in the face of increasing land use and climate pressures. Other audiences served by the results of this research include those interested in mapping and monitoring Minnesota's natural resources for conservation. The project has served the climate change research community by developing a novel algorithm to map changes in forest cover over large areas.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
132	Weather and Climate
605	Natural Resource and Environmental Economics

Outcome #4

1. Outcome Measures

Of participants, the number that adopted recommended adaptation strategies for production agriculture and natural resources management, including invasive species, pest management, pollutant loads, wetlands.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Research will develop new knowledge and technologies related to climate change. (Measure: number of new crop varieties and genotypes with climate adaptive traits; number of new assessment and management tools developed, including models and measurements; number of new climate relevant databases, monitoring systems and inventories managed or under development)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
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2013

0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Weed management strategies that have been developed over the last fifty years are being substantially challenged by climate changes. It is critical that adaptive strategies be developed to meet new realities facing growers. Strategies are needed that will not only help control new weeds in growers' fields, but could help maintain growers' profitability.

What has been done

Pennycress was evaluated as an oil seed crop when grown in a double crop system with soybean. Results showed that pennycress provides excellent control of spring emerging weeds, and reduced weed biomass by 80-to-100 percent. With pennycress's early harvest date, a full season soybean can be grown on the same acreage immediately following harvest with no loss of yield.

Results

The most productive U of M lines of pennycress currently produce seed with approximately 30-40 percent oil by weight with a composition that is suitable for conversion to biodiesel, aviation biofuels and other industrial products. Planting pennycress as a winter annual double-crop has the potential to add an additional profit for corn and soybean producers, besides out-competing new invasive weeds due to climate change.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Volunteers are mobilized to actively monitor seven key indicator species to examine climate variability. (Outcome is the number of volunteers who are engaged in reporting data to a web portal.)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
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2013

30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Phenology, a branch of science dealing with the relationship between climate and periodic biological phenomena (such as bird migration or plant flowering), provides an opportunity to monitor the effects of changing climate. The USA National Phenology Network "encourages people of all ages and backgrounds to observe and record phenology as a way to discover and explore the nature and pace of our dynamic world."

What has been done

Extension developed and piloted a program that engages volunteers to monitor and report phenology that indicates climate variability in Minnesota. Eighteen experts were enlisted to identify potential species to monitor in Minnesota. Citizen phenologists were surveyed to rank a final list of species that are easy to identify and known to be sensitive to climate variability: the Loon, Red Maple, Tamarack, Lilac, Monarch, Bluebird and Ruby Throated Hummingbird. National protocols (www.usanpn.org) were adapted to create monitoring guidelines.

Results

Training and presentation materials reached 37 adults. A web portal was developed for online data entry and review. Every participant reported learning to monitor seven key indicator species for climate variability; 80% reported on post-workshop surveys that they have a realistic plan to monitor these species and report data to the web-based reporting system. Resulting data can inform and empower scientists, resource managers, and the public in decision-making and adapting to variable and changing climates and environments.

4. Associated Knowledge Areas

KA Code	Knowledge Area
132	Weather and Climate

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Other (Degree of climate change)

Brief Explanation

Minnesota was second among states with high catastrophe losses in 2007 and ranked third in 2008. As more climate events have affected the U.S. and Minnesota, readiness to discuss climate change and consider adaptation has increased. This has created a groundswell of support for multi-disciplinary education for those working in government,

agriculture, business, and other sectors.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

To date, evaluation has tracked the usefulness and relevance of information shared with those interested in adaptation, as well as the intention of participants in events to act in some way. As efforts to educate and mobilize volunteers grow in maturity, changes in behaviors and conditions for adaptation to climate change can be measured.

Key Items of Evaluation

In 2013, Extension mobilized and trained 30 citizen phenologists who will monitor and record changes in species that are to identify and known to be sensitive to climate variability: the Loon, Red Maple, Tamarack, Lilac, Monarch, Bluebird and Ruby Throated Hummingbird. This new effort will result in the availability of information and resources to scientists and others who are considering the degree and impact of climate change.