

V(A). Planned Program (Summary)

Program # 7

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	15%	15%	15%	15%
111	Conservation and Efficient Use of Water	10%	10%	10%	10%
132	Weather and Climate	10%	10%	10%	10%
136	Conservation of Biological Diversity	5%	5%	5%	5%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%	10%	10%	10%
205	Plant Management Systems	10%	10%	10%	10%
305	Animal Physiological Processes	10%	10%	10%	10%
307	Animal Management Systems	10%	10%	10%	10%
311	Animal Diseases	5%	5%	5%	5%
601	Economics of Agricultural Production and Farm Management	5%	5%	5%	5%
605	Natural Resource and Environmental Economics	5%	5%	5%	5%
903	Communication, Education, and Information Delivery	5%	5%	5%	5%
	Total	100%	100%	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	6.8	0.9	19.4	1.2
Actual Paid Professional	6.8	1.1	21.0	1.2
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
403408	150042	643518	116859
1862 Matching	1890 Matching	1862 Matching	1890 Matching
332534	150042	445573	116859
1862 All Other	1890 All Other	1862 All Other	1890 All Other
644519	12500	3162766	179682

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research and extensions programs will focus on: (1) Animal agriculture: understanding impacts of climate change on animal physiological processes, health, and disease, particularly for poultry and dairy; developing management practices to rapidly diagnose, prevent, and mitigate (e.g., new vaccines) effects of avian diseases on poultry health and productivity, including current disease problems and new ones that may appear and proliferate under new climatic conditions; developing new systems and technologies to reduce effects of environmental stress on animal health and productivity; (2) Agronomic crops: basic research on how environmental stresses associated with climate change (e.g., heat, moisture stress) affect crop physiology and productivity; plant genetics and breeding studies to develop cultivars of major crops better adapted to a changing climate, in terms of water use efficiency and resistance to insects and disease; applied research and extension programs on irrigation management and water use efficiency for periods of prolonged drought and restricted water use and for groundwaters that may become more saline from salt water intrusion; integrated pest management to diagnose and control insects, weeds, and diseases (current and newly emerging) during longer growing seasons and under warmer and wetter growing conditions; nutrient cycling and management, particularly for manures and other byproducts where decomposition and nutrient release rates and timings are affected by warmer, wetter climates; basic and applied research on factors controlling C sequestration and new agronomic management practices that help mitigate greenhouse gas emissions by sequestering C in soils; New research and extension demonstration programs are focusing on the potential to increase barley and sweet sorghum acreage in response to growing interest in use of these crops for ethanol production; (3) Natural Ecosystems: characterizing effects of climate change on biodiversity of plants and wildlife exposed to greater pressure from droughts, insects, disease, and invasive species; studying how climate change affects natural ecosystems and insects critical to crop production (e.g., pollination, honeybees); investigate value of marshes, wetlands, and forests to sequester C; increase C storage by encouraging tree planting and sustainable forestry management, (4) Resource economics: develop creative new economic policies to profitably link agriculture and forestry with those sectors generating significant quantities of greenhouse gases (e.g., energy, transportation) in cooperative efforts to mitigate greenhouse gas emissions; improve understanding of the relationship of climate change to agricultural and environmental policy development, including farmland preservation, conservation reserve programs; study impacts of climate change on groundwater aquifers, integrate climate change into Chesapeake Bay water quality model; contribute to policies and educational programs on recycling, develop environmentally-friendly bio-based fuels from local feed stocks, and assist in analysis of Delaware's greenhouse gas inventories from energy use (mobile sources, utilities, residential, industrial, transportation, commercial, natural gas distribution, waste management, agriculture, land use, etc.).

2. Brief description of the target audience

For animal agriculture, primarily poultry integrators, growers, breeders, trade groups and allied industries; dairy and beef producers; livestock commodity groups; forage producers, equine owners, producers and interest groups; for crop and soils related research and extension programs, the audience includes existing and prospective grain crop producers, mixed (animal and crop production, e.g., dairy, horse) farms, crop commodity groups and trade associations, the "green industry" (e.g., horticulture, nurseries, landscapers), and certified crop advisors; for natural resource and ecology programs, private and not-for-profit organizations managing forests, wetlands, marshes, and other natural resource areas; state and federal agencies responsible for wildlife, forestry management, and coastal ecosystems; for our resource economic programs the audience includes farmers, landowners, policy-makers and state and federal agencies directly related to climate change policy (Delaware Development Office; Land Use Planning and Preservation; Department of Agriculture; Department of Health and Human Services; Department of Natural Resources & Environmental Control; Department of Transportation; Economic Development Office, USDA, NRCS, USEPA). For all programs, Delaware State Government and local legislators, homeowner associations, educators, community leaders, utility managers, retail stores distributing Energy Star products, fleet managers, building industry, Delaware Clean State Program members, Delaware Farm Bureau leaders, federal-state-local agriculture businesses, state and federal agencies; federal research laboratories; peer scientists in the U.S. and international colleagues, K-12 teachers, and environmental and community groups.

3. How was eXtension used?

Not reporting this year.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	18470	19157	180	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	3	53	56

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Competitive Grants Submitted

Year	Actual
2012	69

Output #2

Output Measure

- Number of Competitive Grants Awarded

Year	Actual
2012	37

Output #3

Output Measure

- Number of Research Projects Completed

Year	Actual
2012	45

Output #4

Output Measure

- Number of Undergraduate Researchers

Year	Actual
2012	60

Output #5

Output Measure

- Number of M.S. Graduate Students

Year	Actual
2012	32

Output #6

Output Measure

- Number of Ph.D. Graduate Students

Year	Actual
2012	24

Output #7

Output Measure

- Number of Post-doctoral Research Associates

Year	Actual
2012	10

Output #8

Output Measure

- Number of Refereed Journal Articles

Year	Actual
2012	56

Output #9

Output Measure

- Number of Books and Book Chapters

Year	Actual
2012	7

Output #10

Output Measure

- Number of Technical Reports

Year	Actual
2012	32

Output #11

Output Measure

- Number of Extension Bulletins and Factsheets

Year	Actual
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2012 26

Output #12

Output Measure

- Number of Invited Presentations

Year	Actual
2012	133

Output #13

Output Measure

- Number of Volunteered Presentations

Year	Actual
2012	101

Output #14

Output Measure

- Number of Websites Established

Year	Actual
2012	1

Output #15

Output Measure

- Number of Workshops Conducted

Year	Actual
2012	16

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Educational programs for the poultry, livestock and equine industries on likely effects of climate change on animal health, productivity, the incidence of disease, greater energy costs due to warmer temperatures, and their management options to prevent new problems.
2	Greater awareness by farmers, the "Green Industry", other producers, and land managers of the types and possible magnitude of climate change impacts on crop production, with an emphasis on drought and irrigation management, increased incidences and diversity of pest pressures from insects, disease, and weeds, and nutrient cycling and transport for different crop rotations and tillage systems.
3	Outreach programs and demonstration projects on underlying principles and soil management programs now available to enhance carbon sequestration by agriculture, forestry, and other natural ecosystems (e.g., marshes, wetlands).
4	Educational programs for K-12 teachers, policy-makers, and the public on climate change and its potential effects on agriculture, natural ecosystems, and current and proposed approaches and new policies that could mitigate problems associated with climate change.
5	Increased number of poultry and livestock producers adopting management practices specifically designed to mitigate disease and animal health problems associated with climate change, particularly those related to year-round warmer conditions and weather extremes.
6	Increased number of crop producers adopting management practices specifically designed to mitigate plant growth problems associated with climate change, particularly those related to drought, pest pressures, and nutrient use.
7	Development of systematic strategies and plans to address climate change impacts on natural resource areas, particularly those related to plant species change, loss of biodiversity, wildlife ecology, and invasive plants.
8	Increased number of farmers, natural resource managers, and others aware of and participating in programs related to mitigating greenhouse gas emissions through programs such as carbon credits and carbon trading.
9	Greater scientific understanding of the fundamental mechanisms by which climate change affects plant and animal physiological processes, soil biological and chemical processes, and ecosystem health, with particular emphasis on challenges due to plant and animal diseases, water use efficiency, and biodiversity
10	Successful adoption of research-based management practices and economic policies that sustain animal agriculture, ensure crop productivity, protect or restore natural resource areas negatively impacted by climate change, and reduce greenhouse gas emissions.

Outcome #1

1. Outcome Measures

Educational programs for the poultry, livestock and equine industries on likely effects of climate change on animal health, productivity, the incidence of disease, greater energy costs due to warmer temperatures, and their management options to prevent new problems.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Feed comprises the largest portion of livestock production costs. Corn and soybeans are main ingredients in livestock and specifically beef cattle diets. Beef producers have been facing significant increases in feed costs over the past few years. This is a result of issues such as competition for feedstuffs from the production of renewable fuels like ethanol and biodiesel and varying degrees of drought. As a result, it is important to look at maximizing the use of less costly sources of feed for cattle.

What has been done

Of the 38 producers in attendance at the workshop, responses given indicated that attendees rated the workshop (utilizing a Likert scale) as "Very Useful" with an average score of 4.2 out of 5. 92% of attendees indicated that their knowledge of utilizing pasture as main feed source and techniques for extending the grazing season increased as a result of participation in the workshop. 77% indicated that they would be applying some of the methods learned in the workshop in their own cattle operation within the next year.

Results

The majority of beef cattle producers in Delaware are cow calf operations that could more efficiently and effectively utilize pasture as a main feed source for their cattle herd. Cooperative Extension professionals designed a beef cattle workshop that focused on maximizing production of cattle feed from pasture based sources. In addition to presenting methods for extending the grazing season to maximize days on pasture, solutions also focused on modifying the cattle management calendar to better match cattle demand with pasture production. Information on new forage crops for grazing was also shared with producers. Finally, information on irrigation programs available to producers to assist in maximizing pasture yield was also presented.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
307	Animal Management Systems
311	Animal Diseases
903	Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

Greater awareness by farmers, the "Green Industry", other producers, and land managers of the types and possible magnitude of climate change impacts on crop production, with an emphasis on drought and irrigation management, increased incidences and diversity of pest pressures from insects, disease, and weeds, and nutrient cycling and transport for different crop rotations and tillage systems.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Climate change and drought have meant that growers are looking to irrigation to increase farm profits.

What has been done

The University of Delaware Irrigation Program invited farmers, industry and the general public to tour UD's Warrington Irrigation Research Farm on Wednesday, Sept. 19. UD Irrigation Engineer James Adkins along with Sussex County Agent Cory Whaley and Kent County Agent Phillip Sylvester presented the following: First year experiences with Subsurface Drip Irrigation (SDI): Tour the newly installed 42 zone SDI research facility and discuss the potential of SDI to irrigate previously uneconomical fields. Join in a candid discussion of the benefits and challenges of SDI in sandy soils and the nuances every farmer should consider before installation. The Potential for Variable Rate Center Pivot Irrigation (VRI): Discuss the feasibility, practicality and affordability of VRI as a tool to improve irrigation management in highly variable fields. View a

the UD 4 tower VRI system and the potential applications of VRI technology outside of irrigation research. Soil Moisture Monitoring as a Tool to Refine Irrigation Management: View many of the various options to monitor soil moisture levels with a discussion of the pros and cons of each option. Irrigated Corn, Full Season and Double Soybean Irrigation Research Plots: Discuss the preliminary results of multiyear irrigation research to improve the yields of irrigated agronomic crops.

Results

Farmers in the region are seeking irrigation information from UD's irrigation experts as they look to drought solutions. Combined research and extension programs led by the UD Irrigation Team are providing research-based solutions that are leading to more efficient use of water and energy to mitigate the effects of drought on crop production in Delaware's sandy soils.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
132	Weather and Climate
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

Outreach programs and demonstration projects on underlying principles and soil management programs now available to enhance carbon sequestration by agriculture, forestry, and other natural ecosystems (e.g., marshes, wetlands).

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Forestry can serve carbon sequestration needs and provide for an alternative to fossil fuels.

What has been done

UD renewable resources gave a presentation at the 2012 Delaware Arborist Conference to a diverse audience of 100+ tree care businesses and individuals.

Results

This presentation resulted in two major companies and one large community in Sussex investing in procedures to utilize urban wood residues for bioenergy activities instead of mulching applications; hopefully this action will stimulate a change in the current Delaware legislation prohibiting bioenergy combined heat & power facilities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate
205	Plant Management Systems
605	Natural Resource and Environmental Economics
903	Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

Educational programs for K-12 teachers, policy-makers, and the public on climate change and its potential effects on agriculture, natural ecosystems, and current and proposed approaches and new policies that could mitigate problems associated with climate change.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Increased number of poultry and livestock producers adopting management practices specifically designed to mitigate disease and animal health problems associated with climate change, particularly those related to year-round warmer conditions and weather extremes.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Increased number of crop producers adopting management practices specifically designed to mitigate plant growth problems associated with climate change, particularly those related to drought, pest pressures, and nutrient use.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There is a great deal of diversity in corn found in the tropics, but that diverse corn has been underutilized in the U.S., mainly because the corn raised in tropical areas are unadapted to North American environments.

What has been done

The University of Delaware's Randall Wisser and a group of six fellow researchers have received a five-year grant to study the genetics of adaptation and crop improvement. Populations that lack genetic diversity can fall prey to climate change or other stressors by not having an array of genes on which to draw from. Breeding-based solutions to addressing abiotic and biotic challenges require access to genetic diversity.

Results

Through its research, the team aims to help plant breeders increase breeding efficiency and access more genetic diversity, increasing their capability of responding to current and future challenges in food production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
132	Weather and Climate

203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management
605	Natural Resource and Environmental Economics
903	Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

Development of systematic strategies and plans to address climate change impacts on natural resource areas, particularly those related to plant species change, loss of biodiversity, wildlife ecology, and invasive plants.

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Increased number of farmers, natural resource managers, and others aware of and participating in programs related to mitigating greenhouse gas emissions through programs such as carbon credits and carbon trading.

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Greater scientific understanding of the fundamental mechanisms by which climate change affects plant and animal physiological processes, soil biological and chemical processes, and ecosystem health, with particular emphasis on challenges due to plant and animal diseases, water use efficiency, and biodiversity

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Successful adoption of research-based management practices and economic policies that sustain animal agriculture, ensure crop productivity, protect or restore natural resource areas negatively impacted by climate change, and reduce greenhouse gas emissions.

Not Reporting on this Outcome Measure

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
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation of the Climate Change planned program shows growing activity in research and extension in this area as faculty and extension professionals have begun to incorporate a range of aspects on climate change into existing projects and launch new studies where climate change impacts are a central component. Nearly 70 grants supported the efforts of 126 graduate students, post-docs, and undergraduate researchers who conducted studies in areas that would be affected by expected changes in future climates. Similarly, 56 refereed journal articles, 234 invited and volunteered presentations, and 121 workshops were completed in areas where climate change impacts must be considered more carefully in the future. Our evaluations suggest that farmers, land managers, state and federal agencies, environmental groups, and the public value efforts to determine how current priority areas for research in Delaware may be affected by the anticipated changes in future climate

Key Items of Evaluation

There are no major items requiring NIFA attention at this time, other than the continued need for more federal funding for research and extension programs that seek to incorporate potential climate change impacts into current and planned projects on areas of high priority to Delaware.