

# 2012 University of Missouri Research Annual Report of Accomplishments and Results

<b>Status: Accepted</b>
<b>Date Accepted: 05/21/2013</b>

## I. Report Overview

### 1. Executive Summary

In 2012, the Midwest suffered through the most severe drought in decades. In terms of scope and severity, drought conditions were the worst experienced since the 1930's Dust Bowl. The drought had a significant impact on crop yields and forage supplies and a far reaching effect on commodity prices. The high cost and lack of availability of forage forced many ranchers to send their herds to slaughter.

Uncontrollable extremes in factors such as weather and climate that directly impact production underscore the need for basic and applied research in agricultural. Research is fundamental to increasing the ability to respond to changing agronomic conditions as well as developing new opportunities to increase productivity or decrease environmental degradation.

Researchers at the University of Missouri are developing a model to understand how climate influences fire regimes to improve the prediction of wildfire threat. To help stretch forage supplies in drought stricken regions, animal nutrition specialists are experimenting with treatment processes that will improve the nutritional content of low quality hay and corn stover. In cropping systems, researchers are utilizing wireless technology to develop best irrigation practices for cotton. MU investigators are using advanced Doppler technology to get detailed information about how a rain event impacts the runoff load to a watershed. In the area of sustainable energy, MU scientists in bioprocessing are developing systems to change refuse organic material into methane gas on a large scale using bio-digesters. These systems will optimize the conversion of organic waste into a useful form of energy.

#### Total Actual Amount of professional FTEs/SYs for this State

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	74.0	0.0
Actual	0.0	0.0	75.0	0.0

## II. Merit Review Process

### 1. The Merit Review Process that was Employed for this year

- Other (see below )

### 2. Brief Explanation

Annual faculty reporting instruments, including individual report of accomplishments and the station project progress reports were used to gauge program progress. In addition, information in media releases and web publications was used to highlight milestone events reported in 2012.

### **III. Stakeholder Input**

#### **1. Actions taken to seek stakeholder input that encouraged their participation**

- Other (see MU Extension Plan of Work)

##### **Brief explanation.**

MU Extension sought input from traditional and non-traditional stakeholder groups by invitation and survey processes.

#### **2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them**

##### **1. Method to identify individuals and groups**

- Use Advisory Committees

##### **Brief explanation.**

Program administrators met with commodity groups and advisory boards to collect their input.

#### **2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them**

##### **1. Methods for collecting Stakeholder Input**

- Other (see MU Extension Plan of Work)

##### **Brief explanation.**

#### **3. A statement of how the input will be considered**

- Other (see MU Extension Plan of Work)

##### **Brief explanation.**

MU Extension personnel share results of the stakeholder input process with AES researchers. Most faculty appointments include both research and extension responsibilities, further strengthening the linkages between extension and research.

#### **Brief Explanation of what you learned from your Stakeholders**

see MU Extension Plan of Work

IV. Expenditure Summary

<b>1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)</b>			
<b>Extension</b>		<b>Research</b>	
<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
0	0	6050646	0

<b>2. Totaled Actual dollars from Planned Programs Inputs</b>				
<b>Extension</b>			<b>Research</b>	
	<b>Smith-Lever 3b &amp; 3c</b>	<b>1890 Extension</b>	<b>Hatch</b>	<b>Evans-Allen</b>
<b>Actual Formula</b>	0	0	6711771	0
<b>Actual Matching</b>	0	0	6711771	0
<b>Actual All Other</b>	0	0	1465694	0
<b>Total Actual Expended</b>	0	0	14889236	0

<b>3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous</b>				
<b>Carryover</b>	0	0	0	0

## V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Global Food Security and Hunger
2	Climate Change
3	Sustainable Energy
4	Childhood Obesity
5	Food Safety
6	Natural Resources and Quality of Life

**V(A). Planned Program (Summary)**

**Program # 1**

**1. Name of the Planned Program**

Global Food Security and Hunger

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
111	Conservation and Efficient Use of Water			4%	
201	Plant Genome, Genetics, and Genetic Mechanisms			8%	
202	Plant Genetic Resources			4%	
205	Plant Management Systems			6%	
206	Basic Plant Biology			10%	
211	Insects, Mites, and Other Arthropods Affecting Plants			3%	
212	Pathogens and Nematodes Affecting Plants			8%	
216	Integrated Pest Management Systems			3%	
301	Reproductive Performance of Animals			11%	
302	Nutrient Utilization in Animals			6%	
303	Genetic Improvement of Animals			4%	
304	Animal Genome			7%	
305	Animal Physiological Processes			4%	
306	Environmental Stress in Animals			3%	
311	Animal Diseases			6%	
402	Engineering Systems and Equipment			3%	
404	Instrumentation and Control Systems			2%	
405	Drainage and Irrigation Systems and Facilities			3%	
601	Economics of Agricultural Production and Farm Management			5%	
	<b>Total</b>			100%	

**V(C). Planned Program (Inputs)**

**1. Actual amount of FTE/SYs expended this Program**

Extension	Research

<b>Year: 2012</b>	<b>1862</b>	<b>1890</b>	<b>1862</b>	<b>1890</b>
	0.0	0.0	47.0	0.0
Plan	0.0	0.0	44.0	0.0
Actual Paid Professional	0.0	0.0	0.0	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	4564070	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	4564070	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	107892	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

Basic and translational research will be conducted and the results disseminated via scientific publications, scientific meetings, web publications, workshops, conferences, etc.

**2. Brief description of the target audience**

Researchers, scientists, extension specialists, field operation managers, agricultural producers

**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: 16

**Patents listed**

J.T. English, F.J. Schmidt, Z.D. Fang, J.E. Schoelz. 2010. Combinatorially selected peptides for protection of soybean against *Phakopsora pachyrhizi*. Patent Appl #61/330,173. United States Patent No. 7,927,828; issued on April 19, 2011; "Immunoassay for Venom Detection Including Noninvasive Sample Collection"  
 Inventors: William V. Stoecker, Rolla, MO; Hernan F. Gomez, Whitmore Lake, MI; Jonathan A. Green, Columbia, MO;  
 # 7 906 702 Categorically Ranking Animals for Feed Efficiency  
 Welsh, M.J., C. Rogers, R.S. Prather, J. Engelhardt, Z. Yan. "Method of identifying compounds using a transgenic pig model of cystic fibrosis", Provisional patent filed March 30, 2007, U.S. #7,989,657 (issued Aug. 2, 2011).  
 United States Patent No. 8,067,669, English, J, Schmidt, F.J., Stacey, G. and Fang, Z, Method for inducing resistance to fungal infection in transgenic plants using plant defense peptides. Nov. 29, 2011  
 United States Patent No. 8,097,771 B2, Wan, J, Stacey, G, Stacey, M, and Zhang, X. LysM receptor-like kinases to improve plant defense response against fungal pathogens. Jan 17, 2012  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC013, "S08-8440RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC014, "S08-8467RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC015, "S08-9936RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC016, "S08-9942RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC017, "S08-9727RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC018, "S08-14072RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC019, "S08-14087RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC020, "S08-14117RR soybean".  
 Shannon, G., H. Nguyen, A. Wrather, M. Woolard, S. Smothers. 2010. UM Disclosure No 12UMC021, "S08-17361RR soybean".  
 Zhang Z and Park S. 2011. Methods for improving plant transformation. Patent disclosure  
 Zhang Z, Baykal U. 2011. Novel construct designs for effective use of trans-acting small interference RNA (tasiRNA) technology. Patent disclosure

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2012	Extension	Research	Total
Actual	0	314	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of peer reviewed journal articles

<b>Year</b>	<b>Actual</b>
2012	176

**Output #2**

**Output Measure**

- Number of other peer reviewed publications (book chapters, proceedings, abstracts, etc.)

<b>Year</b>	<b>Actual</b>
2012	125

**Output #3**

**Output Measure**

- Number of invited papers and invited presentations

<b>Year</b>	<b>Actual</b>
2012	154

**Output #4**

**Output Measure**

- Number of graduate degrees awarded

<b>Year</b>	<b>Actual</b>
2012	32



**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Research efforts will result in enhanced understanding of basic aspects of plant physiology and biochemistry. This knowledge will facilitate the development of better cropping management systems and improved plant varieties that have stronger disease or drought resistance, or value added traits.
2	The research efforts will result in new knowledge that will improve our understanding of animal physiology, genetics, reproduction, nutrition, growth, and animal well being. This knowledge will be translated to better animal production practices and improved animal production efficiency. In addition, students will be trained for positions in animal production, industry, government, and research/teaching.

## **Outcome #1**

### **1. Outcome Measures**

Research efforts will result in enhanced understanding of basic aspects of plant physiology and biochemistry. This knowledge will facilitate the development of better cropping management systems and improved plant varieties that have stronger disease or drought resistance, or value added traits.

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

The timing and quantity of water applied on irrigated cotton has a major impact on crop yield. Cotton yields suffer if too little, or even too much, water is applied through irrigation. Farmers can benefit from real time information on soil moisture so that the optimal amounts of irrigation can be applied at the appropriate time.

#### **What has been done**

Researchers at the University of Missouri are investigating wireless technology to develop best practices to achieve optimum regimes for irrigating cotton. Soil moisture sensors are placed at four depths in the soil profile. In addition, the soil texture and permanent wilting point (the minimal amount of soil moisture required for a plant not to wilt) are determined so that irrigation can be triggered by the percent of total available water. This smart-scheduling irrigation method is based on the actual amount of water in the soil that remains available to the plant, as opposed to estimated soil moisture based on computer programs using weather data.

#### **Results**

Using remote wireless sensors to gauge soil moisture significantly improves the information guiding irrigation parameters. Measuring actual on site soil moisture levels, rather than general estimates based on weather data, greatly enhances control of the one of the most critical management variables in growing crops. This wireless system conserves resources, can boost yields and can save farmers money.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
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111	Conservation and Efficient Use of Water
205	Plant Management Systems
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

## **Outcome #2**

### **1. Outcome Measures**

The research efforts will result in new knowledge that will improve our understanding of animal physiology, genetics, reproduction, nutrition, growth, and animal well being. This knowledge will be translated to better animal production practices and improved animal production efficiency. In addition, students will be trained for positions in animal production, industry, government, and research/teaching.

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

For the past 2 years, Missouri farmers have endured a significant drought that has significantly reduced forage supplies for livestock. In drought stricken regions, forage is not only in short supply, but what is available is often of poor quality. Furthermore, because pasture reserves are quickly decimated under drought conditions, producers are forced to feed stored forage or even take animals to market because of insufficient forage supplies.

#### **What has been done**

Researchers at the University of Missouri are experimenting with the optimal process for treating low quality forage with anhydrous ammonia to improve digestibility and protein content. Roughage is covered with a polyethylene sheet to create an air and ammonia tight seal. Anhydrous ammonia is injected into the stack and allowed to react with the roughage. The addition of anhydrous ammonia increases the nitrogen content of the forage thereby increasing its protein content.

#### **Results**

In persistent drought conditions, forage supplies are very limited and what is available is often of poor quality. Researchers are experimenting with treatment processes that will improve the nutritional content of hay and corn stover. Results indicate that the digestibility of low quality

forage improves by 15 percent while the protein content is doubled.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
305	Animal Physiological Processes

#### V(H). Planned Program (External Factors)

##### External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Competing Public priorities

##### Brief Explanation

#### V(I). Planned Program (Evaluation Studies)

##### Evaluation Results

Individual faculty were reviewed by their respective Division Directors. Faculty submitted their research goals and accomplishments. Besides evaluating individual progress, the Division Directors reviewed research progress and accomplishments in the context of the planned program. Results show continued progress in both basic and applied research.

Points of evaluation included the following:

Research focus: Was it relevant and consistent with the objectives of the planned program?

Successful scholarship: Were research results conveyed through peer reviewed publications?

Successful grantsmanship: Was the research quality high enough to successfully compete for external grant funds?

##### Key Items of Evaluation

- Peer reviewed publications
- Grant submission
- Presentations and communication of results
- Popular media exposure

**V(A). Planned Program (Summary)**

**Program # 2**

**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
122	Management and Control of Forest and Range Fires			30%	
132	Weather and Climate			46%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			24%	
	<b>Total</b>			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	2.0	0.0
Actual Paid Professional	0.0	0.0	5.0	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	427214	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	427214	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	116949	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

Models of long range forecasting and climate change will be developed and results disseminated via scientific publications, scientific meetings, websites, workshops, conferences, etc.

**2. Brief description of the target audience**

Researchers, atmospheric scientists, agricultural scientists, agricultural producers, extension specialists

**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	0	26	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of peer reviewed journal articles

**Year Actual**

2012 23

**Output #2**

**Output Measure**

- Number of other peer reviewed publications (book chapters, proceedings, abstracts, etc.)

<b>Year</b>	<b>Actual</b>
2012	3

**Output #3**

**Output Measure**

- Number of invited papers and invited presentations

<b>Year</b>	<b>Actual</b>
2012	19

**Output #4**

**Output Measure**

- Number of graduate degrees awarded

<b>Year</b>	<b>Actual</b>
2012	8

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Increased understanding of the synoptic and planetary-scale atmospheric processes and improved models of long range forecasting and climate change.



## **Outcome #1**

### **1. Outcome Measures**

Increased understanding of the synoptic and planetary-scale atmospheric processes and improved models of long range forecasting and climate change.

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Wildfire activity in 2012 ranked third in most acres burned, exceeded only by the records set in 2006 and 2007. The high incidence and severity of fire outbreaks in recent history has heightened the concern that climate change is a contributing factor. Fire scientists have concentrated on monitoring vegetation as a fuel source to evaluate wildfire threat levels, but this information may be difficult to access and may not even be available in certain parts of the country. Researchers at the University of Missouri are working on a broader approach to understanding fire regimes by using climate information and vast historical data across North America to develop threat assessment techniques that can be applied anywhere on the continent.

#### **What has been done**

Researchers at the University of Missouri have developed a model to understand how climate influences fire regimes across North America. The Physical Chemical Fire Frequency Model (PC2FM), was developed using a hundred years of experimental chemistry and hundreds of years of fire scar history. Using this model, researchers can make broad-scale characterizations of past and future fire regimes and assess sensitivity of the fire regime to climatic changes. Key climatic variables affecting the fire regime are temperature and precipitation.

#### **Results**

Natural resource managers, scientists and the general public can use fire histories and models such as the PC2FM to make informed decisions on the ecology of fire, both in better understanding its past and predicting its future. Such information will help inform wildfire management decisions and be useful in preparing defensive strategies to cope with fire threat levels.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
122	Management and Control of Forest and Range Fires
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
- Competing Public priorities
- Competing Programmatic Challenges

##### **Brief Explanation**

#### **V(I). Planned Program (Evaluation Studies)**

##### **Evaluation Results**

Individual faculty were reviewed by their respective Division Directors. Faculty submitted their research goals and accomplishments. Besides evaluating individual progress, the Division Directors reviewed research progress and accomplishments in the context of the planned program. Results show continued progress in both basic and applied research.

Points of evaluation included the following:

Research focus: Was it relevant and consistent with the objectives of the planned program?

Successful scholarship: Were research results conveyed through peer reviewed publications?

Successful grantsmanship: Was the research quality high enough to successfully compete for external grant funds?

##### **Key Items of Evaluation**

- Peer reviewed publications
- Grant submission
- Presentations and communication of results
- Popular media exposure

**V(A). Planned Program (Summary)**

**Program # 3**

**1. Name of the Planned Program**

Sustainable Energy

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
122	Management and Control of Forest and Range Fires			8%	
123	Management and Sustainability of Forest Resources			34%	
124	Urban Forestry			5%	
125	Agroforestry			36%	
403	Waste Disposal, Recycling, and Reuse			8%	
511	New and Improved Non-Food Products and Processes			9%	
	<b>Total</b>			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	8.0	0.0
Actual Paid Professional	0.0	0.0	7.0	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	330413	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	330413	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	728890	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

Basic and translational research will be conducted and the results disseminated via scientific publications, scientific meetings, web publications, workshops, conferences, etc.

**2. Brief description of the target audience**

Researchers, scientists, extension specialists, agricultural producers

**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
<b>Actual</b>	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**

<b>2012</b>	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Actual</b>	0	56	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of peer reviewed journal articles

<b>Year</b>	<b>Actual</b>
2012	39

**Output #2**

**Output Measure**

- Number of other peer reviewed publications (book chapters, proceedings, abstracts, etc.)

<b>Year</b>	<b>Actual</b>
2012	17

**Output #3**

**Output Measure**

- Number of invited papers and invited presentations

<b>Year</b>	<b>Actual</b>
2012	21

**Output #4**

**Output Measure**

- Number of graduate degrees awarded

<b>Year</b>	<b>Actual</b>
2012	13

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Research across disciplines will be conducted to improve the viability of biomass as an energy source by improving biomass production efficiency, developing new crops and uses, and improving handling and delivery processes for bioenergy products.

## **Outcome #1**

### **1. Outcome Measures**

Research across disciplines will be conducted to improve the viability of biomass as an energy source by improving biomass production efficiency, developing new crops and uses, and improving handling and delivery processes for bioenergy products.

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Over 34 million tons of food waste was generated in 2010, more than any other material category except paper. According to the Environmental Protection Agency, only a small fraction was recycled, with the remaining 33 million representing the single largest component reaching landfills and incinerators. This waste has the potential to be converted from an environmental detriment to a new source of energy.

#### **What has been done**

MU scientists in bioprocessing are developing systems to change refuse organic material into methane gas on a large scale using bio-digesters. Researchers work to find the perfect combination of conditions and additions to optimize methane production. Trials are conducted on the bacterial systems that anaerobically convert the organic waste into methane. Additives such as algae powder and sodium bicarbonate are used to increase methane production while preventing the mixture from converting to vinegar.

#### **Results**

Converting organic waste into methane reduces pollution and creates a useful form of energy. By developing digester systems to optimize energy output, this conversion can be done effectively on a large scale. The end result decreases pollution and maximizes the energy yield from what was previously treated as waste.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

## **V(H). Planned Program (External Factors)**

### **External factors which affected outcomes**

- Economy
- Appropriations changes
- Public Policy changes
- Competing Public priorities
- Competing Programmatic Challenges

### **Brief Explanation**

## **V(I). Planned Program (Evaluation Studies)**

### **Evaluation Results**

Individual faculty were reviewed by their respective Division Directors. Faculty submitted their research goals and accomplishments. Besides evaluating individual progress, the Division Directors reviewed research progress and accomplishments in the context of the planned program. Results show continued progress in both basic and applied research.

Points of evaluation included the following:

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Successful scholarship: Were research results conveyed through peer reviewed publications?

Successful grantsmanship: Was the research quality high enough to successfully compete for external grant funds?

### **Key Items of Evaluation**

- Peer reviewed publications
- Grant submission
- Presentations and communication of results
- Popular media exposure



**V(A). Planned Program (Summary)**

**Program # 4**

**1. Name of the Planned Program**

Childhood Obesity

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
502	New and Improved Food Products			32%	
702	Requirements and Function of Nutrients and Other Food Components			57%	
703	Nutrition Education and Behavior			11%	
	<b>Total</b>			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	2.0	0.0
Actual Paid Professional	0.0	0.0	3.0	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	236787	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	236787	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

Research will be conducted and the results disseminated via scientific publications, scientific meetings, web publications, workshops, conferences, etc.

**2. Brief description of the target audience**

Food industry scientists, researchers, nutritional scientists, extension specialists

**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	0	7	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of peer reviewed journal articles

Year	Actual
2012	2

**Output #2**

**Output Measure**

- Number of other peer reviewed publications (book chapters, proceedings, abstracts, etc.)

<b>Year</b>	<b>Actual</b>
2012	5

**Output #3**

**Output Measure**

- Number of invited papers and invited presentations

<b>Year</b>	<b>Actual</b>
2012	5

**Output #4**

**Output Measure**

- Number of graduate degrees awarded

<b>Year</b>	<b>Actual</b>
2012	2

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Development of new foods and lifestyle strategies that will help in the fight against obesity.

## **Outcome #1**

### **1. Outcome Measures**

Development of new foods and lifestyle strategies that will help in the fight against obesity.

Not Reporting on this Outcome Measure

### **V(H). Planned Program (External Factors)**

#### **External factors which affected outcomes**

- Appropriations changes
- Public Policy changes
- Competing Public priorities

#### **Brief Explanation**

### **V(I). Planned Program (Evaluation Studies)**

#### **Evaluation Results**

Individual faculty were reviewed by their respective Division Directors. Faculty submitted their research goals and accomplishments. Besides evaluating individual progress, the Division Directors reviewed research progress and accomplishments in the context of the planned program. Results show continued progress in both basic and applied research.

Points of evaluation included the following:

Research focus: Was it relevant and consistent with the objectives of the planned program?

Successful scholarship: Were research results conveyed through peer reviewed publications?

Successful grantsmanship: Was the research quality high enough to successfully compete for external grant funds?

#### **Key Items of Evaluation**

- Peer reviewed publications
- Grant submission
- Presentations and communication of results
- Popular media exposure

**V(A). Planned Program (Summary)**

**Program # 5**

**1. Name of the Planned Program**

Food Safety

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
501	New and Improved Food Processing Technologies			29%	
504	Home and Commercial Food Service			5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			11%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			44%	
723	Hazards to Human Health and Safety			11%	
	<b>Total</b>			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	3.0	0.0
Actual Paid Professional	0.0	0.0	3.0	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	455091	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	455091	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**

Basic and applied research will be conducted and the results disseminated via scientific publications, extension publications, scientific meetings, web publications, workshops, conferences, etc.

**2. Brief description of the target audience**

Food industry scientists, researchers, scientists, extension specialists

**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
<b>Actual</b>	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**

<b>2012</b>	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Actual</b>	0	32	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of peer reviewed journal articles

<b>Year</b>	<b>Actual</b>
2012	13

**Output #2**

**Output Measure**

- Number of other peer reviewed publications (book chapters, proceedings, abstracts, etc.)

<b>Year</b>	<b>Actual</b>
2012	19

**Output #3**

**Output Measure**

- Number of invited papers and invited presentations

<b>Year</b>	<b>Actual</b>
2012	5

**Output #4**

**Output Measure**

- Number of graduate degrees awarded

<b>Year</b>	<b>Actual</b>
2012	4



**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Research will lead to the development of new technologies and processes to improve food safety.

## **Outcome #1**

### **1. Outcome Measures**

Research will lead to the development of new technologies and processes to improve food safety.

Not Reporting on this Outcome Measure

### **V(H). Planned Program (External Factors)**

#### **External factors which affected outcomes**

- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

#### **Brief Explanation**

### **V(I). Planned Program (Evaluation Studies)**

#### **Evaluation Results**

Individual faculty were reviewed by their respective Division Directors. Faculty submitted their research goals and accomplishments. Besides evaluating individual progress, the Division Directors reviewed research progress and accomplishments in the context of the planned program. Results show continued progress in both basic and applied research.

Points of evaluation included the following:

Research focus: Was it relevant and consistent with the objectives of the planned program?

Successful scholarship: Were research results conveyed through peer reviewed publications?

Successful grantsmanship: Was the research quality high enough to successfully compete for external grant funds?

#### **Key Items of Evaluation**

- Peer reviewed publications
- Grant submission
- Presentations and communication of results
- Popular media exposure

**V(A). Planned Program (Summary)**

**Program # 6**

**1. Name of the Planned Program**

Natural Resources and Quality of Life

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
101	Appraisal of Soil Resources			3%	
102	Soil, Plant, Water, Nutrient Relationships			15%	
111	Conservation and Efficient Use of Water			5%	
112	Watershed Protection and Management			14%	
133	Pollution Prevention and Mitigation			5%	
134	Outdoor Recreation			3%	
135	Aquatic and Terrestrial Wildlife			18%	
605	Natural Resource and Environmental Economics			4%	
607	Consumer Economics			2%	
608	Community Resource Planning and Development			6%	
801	Individual and Family Resource Management			6%	
802	Human Development and Family Well-Being			5%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities			5%	
805	Community Institutions, Health, and Social Services			2%	
901	Program and Project Design, and Statistics			3%	
903	Communication, Education, and Information Delivery			4%	
	<b>Total</b>			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	15.0	0.0
Actual Paid Professional	0.0	0.0	13.0	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	698196	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	698196	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	511963	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

Basic and applied research will be conducted to address underlying principles related to natural resources and to assist in the implementation of efficient, effective management actions to conserve natural resources and ensure the sustainable use of those resources. Research will also be conducted in human environmental science. Research findings will be disseminated via appropriate scientific publications, conferences, workshops, trainings, etc.

**2. Brief description of the target audience**

Researchers, scientists, extension specialists, conservation managers, policy makers

**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: 2

**Patents listed**

FOSSIL FUEL-FREE PROCESS OF LIGNOCELLULOSIC PRETREATMENT WITH BIOLOGICAL HYDROGEN PRODUCTION

US Patent #7,943,390 Issued on ?Supported molecular biofluid viscosity sensors for in vitro and in vivo use. M. Haidekker, S.A. Grant, E. Theodorakis, M. Intaglietta, J. Frangos, Date: May 17, 2011.

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2012	Extension	Research	Total
Actual	0	146	0

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Number of peer reviewed journal articles

Year	Actual
2012	95

**Output #2**

**Output Measure**

- Number of other peer reviewed publications (book chapters, proceedings, abstracts, etc.)

Year	Actual
2012	51

**Output #3**

**Output Measure**

- Number of invited papers and invited presentations

Year	Actual
2012	43

**Output #4**

**Output Measure**

- Number of graduate degrees awarded

2012 University of Missouri Research Annual Report of Accomplishments and Results

<b>Year</b>	<b>Actual</b>
2012	22

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Research efforts will result in new knowlege that will lead to improved quality and sustainability of natural and human environments.

## **Outcome #1**

### **1. Outcome Measures**

Research efforts will result in new knowledge that will lead to improved quality and sustainability of natural and human environments.

### **2. Associated Institution Types**

- 1862 Research

### **3a. Outcome Type:**

Change in Knowledge Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

A stream's health is influenced by many factors but nothing is more important than the runoff transported into the stream from its watershed. Understanding the impact of rain events is key to understanding how sediment and other environmental compounds are transported from the watershed to the stream.

#### **What has been done**

Researchers at the University of Missouri are using a Doppler on Wheels (DOW) to get detailed, on-site measurements of rain events. The DOW has advanced features that allow researchers to precisely look vertically into a storm, not just horizontally as conventional radars. This on site tool is used to measure rain intensity, raindrop size and raindrop velocity to get a detailed picture of a rain event. This information is then used to predict details about sediment transport from the watershed.

#### **Results**

The runoff from a rain event directly effects stream health. Better information about the impact from a rain event will lead to a better understanding of how the stream ecology is affected by factors in the watershed and their potential impact on stream health.

### **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife



## **V(H). Planned Program (External Factors)**

### **External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities

### **Brief Explanation**

## **V(I). Planned Program (Evaluation Studies)**

### **Evaluation Results**

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### **Key Items of Evaluation**

- Peer reviewed publications
- Grant submission
- Presentations and communication of results
- Popular media exposure