

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

**Program # 5**

**1. Name of the Planned Program**

Global Food Security and Hunger -- Plant Breeding, Genetics and Genomics

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
201	Plant Genome, Genetics, and Genetic Mechanisms			10%	
202	Plant Genetic Resources			15%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			10%	
204	Plant Product Quality and Utility (Preharvest)			15%	
205	Plant Management Systems			20%	
206	Basic Plant Biology			10%	
502	New and Improved Food Products			5%	
601	Economics of Agricultural Production and Farm Management			5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			5%	
903	Communication, Education, and Information Delivery			5%	
	<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	60.3	0.0
Actual Paid Professional	0.0	0.0	71.2	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	611800	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	3550796	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	2456267	0

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

#### 1. Brief description of the Activity

- Communicated information on plant breeding and genomics advances through classroom activities, field days, cultivar trials, news releases, presentations at county and state meetings, and conventions
- Released germplasm, new cultivars, and new genomics tools and techniques
- Conducted strategic planning with state agricultural groups
- Wrote technical and non-technical publications
- Established biobased product and food science education and research programs
- Enhanced partnerships among faculty across the Montana university system, producers, agricultural industry, and other educational institutions across the region
- Developed research summaries and fact sheets

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

- Domestic and foreign buyers of quality wheat
- Farmers, colleagues, and stakeholders
- Grain associations, Montana Department of Agriculture, Montana Wheat and Barley Committee, grain elevators, and state commodity groups
- Seed companies
- Crop and livestock producers in Montana
- State agricultural advisory committees
- Economic development groups
- Participants in extension and commodity group meetings, conventions, and conferences, and field days
- State of Montana, Montana Department of Agriculture, Bureau of Land Management, USFS, and other government entities

#### 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>	2200	50000	150	0

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

### Patent Applications Submitted

Year: 2012  
 Actual: 2

### Patents listed

A provisional patent, Production of high quality durum wheat having increased amylose content, submitted 9/24/2012, modified 11/29/2012

Provisional Patent: Creation of high molecular weight gluten in alleles with unique dough properties, submitted 10/1/2012

## 3. Publications (Standard General Output Measure)

### Number of Peer Reviewed Publications

2012	Extension	Research	Total
<b>Actual</b>	0	47	47

## V(F). State Defined Outputs

### Output Target

#### Output #1

##### Output Measure

- Number of foreign trade teams in Montana

Year	Actual
2012	17

#### Output #2

##### Output Measure

- Number of foreign trade teams at MSU

Year	Actual
2012	4

**Output #3**

**Output Measure**

- Number of research citations

<b>Year</b>	<b>Actual</b>
2012	123

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

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

O. No.	OUTCOME NAME
1	Electronic documents on new cultivars and Montana district recommendations provided to Montana producers to maintain Montana producers' dominance in small grain markets
2	The number of new molecular techniques used to enhance breeding results
3	Average per bushel yield increase of Montana grains while maintaining product quality
4	Number of elite lines of wheat and barley screened for agronomic and quality characteristics
5	Number of improved cultivar recommendations by districts across Montana
6	Planted acreage percentage increase per year of new MSU-released small grains in Montana
7	Number of programs established to enhance global food biosecurity
8	Number of new food products created from Montana crops

## **Outcome #1**

### **1. Outcome Measures**

Electronic documents on new cultivars and Montana district recommendations provided to Montana producers to maintain Montana producers' dominance in small grain markets

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

- 1862 Research

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

Change in Condition Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	37

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

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

Grain producers in Montana rely heavily on MSU research results for the development of new genetics and cultivars adapted to Montana's climate. New disease and insect resistant wheat and barley cultivars with value-added traits are critical to producers in Montana. Disseminating timely and accurate information about crop selection and results is important in this time sensitive industry.

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

Researchers at MSU developed an online interactive tool to assist growers in selecting proper crops by district. Producers have several input options and the computer assisted program will help them select the best crops for their region. Another new agronomy decision tool assists producers in fertilizer and herbicide selection as well as proposing appropriate irrigation schedules.

#### **Results**

Producers are using the tools and researchers are sharing information about how to best use them prior to crop selection. Information is posted on the sites regarding current analysis of new cultivars and crops along with the most current information on disease and insect resistant strains. The sites provide comprehensive information about new crop recommendations by district.

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

<b>KA Code</b>	<b>Knowledge Area</b>
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)

## **Outcome #2**

### **1. Outcome Measures**

The number of new molecular techniques used to enhance breeding results

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

- 1862 Research

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

Change in Condition Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	1

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

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

Advancements in technology allow scientists to discover new genotypes and breed for favorable traits while eliminating undesirable characteristics.

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

Investigators completed complex field research experiments done with nearly 1,000 experimental lines of dryland and irrigated barley. Other researchers investigated molecular advancements in wheat and leaf rust resistance, and another identified a chromosome in wheat that affected green leaf duration after heading which may be important under drought conditions.

#### **Results**

The barley experiments have been genotyped using a specific marker system, and researchers will utilize the data from the barley experiments to determine how well genome wide selection works compared to phenotypic and marker-assisted selection. Researchers also developed a new through-put molecular marker for leaf rust resistance breeding and a strategy for studying genes in wheat seed development. They published numerous journal articles.

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

<b>KA Code</b>	<b>Knowledge Area</b>
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

204 Plant Product Quality and Utility (Preharvest)

### **Outcome #3**

#### **1. Outcome Measures**

Average per bushel yield increase of Montana grains while maintaining product quality

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

- 1862 Research

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

Change in Condition Outcome Measure

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

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

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

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

Montana ranks first in the production of certified organic wheat and third in the U.S. for wheat and barley production. The grain supports the livestock industry in Montana and the export market. Barley has increased in popularity with Montana producers as the cost per bushel increased for feed and malt barley. Montana produced nearly 20 percent of the barley in the U.S.

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

Investigators with the COA and MAES continued developing hard red spring wheat varieties for farmers and the wheat milling and baking industry. Montana producers planted 2.2 million acres of winter wheat in 2012, ranking fifth in the U.S. for the number of acres planted. Three of the top four varieties planted were developed by the MSU breeding program. Producers planted approximately 2.9 million acres of spring wheat in Montana in 2012.

##### **Results**

Durum, spring, and winter wheat yields dropped in 2011, and 2012 yield statistics have not been published. "Yellowstone," "Genou," and "Rampart" comprised more than half of the total winter wheat planted in 2012. Seeded acres of barley increased by 200,000 but yield dropped due to drought. Winter wheat yields were up an average of 0.73 bu/acre/cycle over 10 breeding cycles (2002-2011). Montana remains the second largest spring wheat producer in the country, according to the USDA NASS, Montana Field Office. "Vida," "Choteau," "Reeder," and "Corbin" accounted for more than 55 percent of Montana's 2012 spring wheat acreage and two of them were developed by the MAES.

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

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<b>KA Code</b>	<b>Knowledge Area</b>
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201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

#### **Outcome #4**

##### **1. Outcome Measures**

Number of elite lines of wheat and barley screened for agronomic and quality characteristics

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

- 1862 Research

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

Change in Condition Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2012	278

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

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

The need for high quality grains increases as the world population grows, and global buyers are looking to Montana as an international leader in the development of new small grain cultivars. Global traders want high quality wheat to enhance food production in breads and noodles, and they are looking for disease and insect resistant plants with high yield potential.

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

Spring wheat researchers screened 64 elite lines under dryland and irrigated conditions. Entries included new solid stem and stay-green lines, and lines with resistance to the orange wheat blossom midge, and hard white wheat lines. Winter wheat program researchers added 214 crosses with emphasis on disease resistance and adaptation traits. There are several new hay barley lines that have one more year of forage yield trials prior to release. "MT 103022" performed well in its first year of testing in the intrastate barley trial.

###### **Results**

Researchers planted the intrastate yield trial at eight locations with yields averaging 58 bu/acre. Seven hollow-stem, one solid-stem, and one "Clearfield" experimental lines were selected for further testing and seed stock purification. Twenty lines were selected for additional testing, and a 49 entry yield trial was planted and harvested and twelve solid stem lines were retained in upper level sawfly trials. 856 lines were evaluated for agronomic potential, 99 harvested, with 60 then selected for preliminary yield testing. These included four hard white and three two-gene "Clearfield" lines. They also screened for reliable grain yield and the plants ability to retain green

leaves after heading. Winter wheat investigators added 284 crosses to the germplasm base, emphasizing disease resistance and adaptation traits.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

#### Outcome #5

##### 1. Outcome Measures

Number of improved cultivar recommendations by districts across Montana

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Condition Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	39

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

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

Montana crop producers want products suitable to domestic and export markets. They want wheat varieties that can thrive under harsh growing conditions and are more insect and disease resistant. As the barley industry grows researchers at MAES and the COA are introducing new varieties that will grow under dryer and warmer conditions.

###### What has been done

The MSU Variety Release Committee released three hard red winter wheat varieties in 2012, "MT 03012" durum wheat, and a high amylose yellow dry pea. They recommended "W.B. Quake" a hard red winter wheat throughout Montana, "Imicht 97" and "Duclair" in dryland areas of Montana, and "Brennan" except in the north-east where it is recommended only under irrigation. "SY Tyra" was also added to the recommended list.

###### Results

A variety is eligible for recommendation when a minimum of 16 location-years of performance data is obtained from the MAES statewide performance trials. Test results must indicate the variety is equal to or superior in overall merit to specified check cultivars and has end-use quality equal to or exceeding currently recommended varieties. Recommendations are considered on a case by case basis. Yield performance is important, but also considered are test weight, grain protein content, disease and pest resistance and end-use quality data. In general, yield needs to be at least equal to currently recommended varieties in a particular district, unless the variety is being recommended for a specific purpose; such as, sawfly resistance.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems

#### Outcome #6

##### 1. Outcome Measures

Planted acreage percentage increase per year of new MSU-released small grains in Montana

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Condition Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2012	0

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

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

Montanans place a lot of trust in Montana State University as a leader in small grain agriculture, and nowhere is it more evident than in seed selection. Producers each year request the latest information and seed options available, so they remain competitive in a tough global grain market.

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

MAES and the COA released "Silver Durum," and two Clearfield hard red winter wheat varieties, "War Horse" and "Colter." In 2011 they released "Hockett" barley, three hard red winter wheat varieties ("Judee," "Bearpaw," and "Decade"), and a new red spring wheat named "Duclair." All of them were recommended in 2012 to districts throughout Montana.

## Results

Field crop revenue for Montana in 2012 totaled \$2.1 billion with wheat the most significant. Montana producers seeded 2.1 million acres of winter wheat last fall for the 2013 crop year, down 200,000 acres or nine percent below the 2012 winter wheat planting of 2.3 million acres. The MSU variety "Yellowstone" continues as the highest yielding winter wheat line ever developed at MSU. "Judee" and "Bearpaw" solid stem semi-dwarf cultivars were released in the fall of 2011 and are expected to soon replace "Genou." "Genou" and "Yellowstone" have increased their yield per acres by 2.8 bu/acre and 6.7 bu/acre since 2007. Spring and durum wheat production were both up as was barley.

## 4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

## Outcome #7

### 1. Outcome Measures

Number of programs established to enhance global food biosecurity

Not Reporting on this Outcome Measure

## Outcome #8

### 1. Outcome Measures

Number of new food products created from Montana crops

### 2. Associated Institution Types

- 1862 Research

### 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)

Discovering new ways to use products increases global food security and keeps consumers engaged. Consumers continue to want more local food options, and they are more interested in how and where it was grown.

#### What has been done

MSU researchers conducted studies on genes important to cereal grain quality and agronomic traits. In 2012, they completed five refereed journal articles with three appearing online and in press. Two others are in press and will be published this year. These manuscripts covered three main topics: plant productivity, grain hardness, and starch quality.

#### Results

MSU research continues to be featured in journals and publications throughout Montana and beyond enhancing knowledge for producers and consumers alike.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
502	New and Improved Food Products
903	Communication, Education, and Information Delivery

### 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
- Other (Funding)

#### Brief Explanation

Montana experienced one of the driest growing seasons on record in much of Southern Montana, but overall had a successful year with the value of all wheat crops up 24 percent from 2011 to \$1.7 billion, according to USDA NASS, Montana Field Office. The all wheat season average price increased \$0.77 per bushel to \$8.45 per bushel.

MSU COA is not reporting on the number of programs established in 2012 to enhance global food biosecurity as accurate data is not available.

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

#### Evaluation Results

The development of improved winter wheat lines and cultivars continues with improvements in yield, disease resistance, and tolerance advances, combined with

improved stem solidness to combat sawfly. New challenges arrive, or former pests mutate to circumvent the remedies developed to thwart their damage and renew their attack on wheat and other crop species.

Montana's spring wheat acreage during the past five years has ranged from 44 to 55 percent of the total wheat acreage planted. In 2012, spring wheat accounted for 48 percent and durum 7.8 percent of the total wheat acreages. In 2012, Montana ranked second among the wheat and durum producing states. The wheat stem sawfly, wheat rust diseases and leaf diseases including Septoria, remain threats to wheat growers in areas across Montana, and require the planting of resistant varieties.

Hard red spring wheat is grown in all areas of the state, with more than 97 percent of the acreage on dryland. The largest concentration of acreage is east of the Continental Divide along the northern tier of counties. The highest producing counties in 2012 were Roosevelt, Valley, and Toole. More than 98 percent of durum wheat is also grown on dryland, and in 2012 the highest producing counties were Sheridan, Daniels, and Roosevelt in northeastern Montana.

"Yellowstone" and "Genou" (cultivars developed by the MSU research program) are the top two planted cultivars in Montana, accounting for about one million acres in 2012. Adoption of these cultivars by Montana wheat growers has resulted in harvest of an additional 21.5 million bushels of winter wheat over the past six crop years (2007-2012) based on production acreage and estimated yield gains over previously deployed cultivars.

Scientists developed improved winter wheat cultivars adapted to Montana cropping systems and climatic conditions. Through molecular and genetic research they discovered plants more resistant to the wheat stem sawfly and made significant strides toward introducing new rust resistant genes into Montana cultivars.

Researchers focused efforts on sugar beet and potato production and discovered biocontrol agents for different disease affecting these crops. The value of the canola crops and safflower increased significantly and producers ranked number one in the U.S. for the production of pulse crops.

The COA and MAES will continue to research and publish results for the agricultural community. New online tools provide immediate information regarding crop and seed recommendations, and researchers are working relentlessly to improve production and profitability of Montana crops.

## Key Items of Evaluation

- "Yellowstone" and "Genou" (cultivars developed by MSU) were the top two planted cultivars in Montana, accounting for about 0.934 million acres in 2012. Adoption of these cultivars by Montana wheat growers has resulted in harvest of an additional 21.5 million bushels of winter wheat over the past six crop years (2007-2012) based on production acreage and estimated yield gains over previously deployed cultivars.
- Completed complex field research experiments with nearly 1,000 experimental lines of dryland and irrigated barley.
- MAES researchers developed and reported a new high throughput molecular marker for leaf rust resistance breeding and a new strategy for studying genes in wheat seed development.

- Researchers demonstrated two important mechanisms in plant triacylglycerol biosynthesis pathway that were published.
- Spring wheat varieties developed by the COA/MAES program were grown on more than one million acres. The two most widely grown varieties in the state, "Vida" and "Choteau," were developed at MSU. In addition, two varieties developed by marker-assisted selection were marketed for the first time in 2012.