

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

**Program # 3**

**1. Name of the Planned Program**

Global Food Security and Hunger -- Integrated Pest Management

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
211	Insects, Mites, and Other Arthropods Affecting Plants			27%	
212	Pathogens and Nematodes Affecting Plants			25%	
213	Weeds Affecting Plants			20%	
215	Biological Control of Pests Affecting Plants			10%	
216	Integrated Pest Management Systems			18%	
	<b>Total</b>			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	33.3	0.0
Actual Paid Professional	0.0	0.0	61.7	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	619903	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	2645002	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	1981868	0

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

**1. Brief description of the Activity**

- Publications will be made available in print and online that provide pest control recommendations
- Regional management guides will be produced
- Research results will be communicated through pesticide workshops and field days
- Research results will be used to support FIFRA Section 18c products labeling requests
- Results will be used to update pesticide applicator training materials
- Training materials will be updated for private and commercial pesticide applicators

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

- Crop producers, dealers, distributors, and crop protection company representatives
- Crop protection companies registration and research personnel
- Montana crop advisory boards
- Private and commercial pesticide applicators
- State of Montana, Montana Department of Agriculture, BLM, USFS, and other government entities

**3. How was eXtension used?**

COA and MAES researchers worked closely with county extension agents and outreach coordinators to disseminate timely and accurate information about integrated pest management topics and issues.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	5000	7000	2000	1000

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

**Patent Applications Submitted**

Year: 2013  
 Actual: 2

**Patents listed**

- 1.) Bacillus Isolates and Methods of their use to protect against plant pathogens and virus 13/175,6148,524,222
- 2.) MNR - 180 Rust Resistant Mutant in Wheat 61/915,380

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

**Number of Peer Reviewed Publications**

<b>2013</b>	<b>Extension</b>	<b>Research</b>	<b>Total</b>
<b>Actual</b>	0	103	0

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

**Output Target**

**Output #1**

**Output Measure**

- Number of research citations

<b>Year</b>	<b>Actual</b>
2013	103

**Output #2**

**Output Measure**

- Multidisciplinary journal articles published

<b>Year</b>	<b>Actual</b>
2013	65

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

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

O. No.	OUTCOME NAME
1	Quality in-depth training programs for continuing education on integrated pest management
2	New IPM options discovered, evaluated, or changed/altered
3	Number of broad-ranging stewardship practices implemented
4	Passing rate percentage for pesticide application licenses
5	New products registered.
6	Number of potential products/practices evaluated

## **Outcome #1**

### **1. Outcome Measures**

Quality in-depth training programs for continuing education on integrated pest management

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

- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2013	241

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

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

An increase in public concern about food safety, quality, cost, biodiversity, and sustainability and quality of soil, air, and water resources is pushing scientists away from pesticides.

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

Researchers explored new and improved methods to identify and control insects, weeds, and disease challenging Montana farmers. They then conducted face-to-face training sessions with members of the Montana agricultural community, conducted webinars for additional participants, and presented at public meetings and seminars. MSU investigators shared low impact pest control options that promote sustainable practices utilizing biological controls.

#### **Results**

The MSU research, teaching, and extension team is bringing awareness to incorporating targeted grazing into farming systems. Researchers with the targeted grazing program spoke at seven locations educating 241 participants as to the benefits of the program, and they shared information at field days. A total of 12 presentations, 6 workshops and several poster-presentations disseminated new research findings, recommendations and information.

Researchers held a pest management tour and visited five locations.

New online information programs are including more data to assist farmers and ranchers with weed and insect identification, including multiple trainings for the United States Forest Service and the Crow Reservation in Montana on identifying rush skeletonweed root moth, and the biological control of weeds and use of insect biocontrol agents. Many radio interviews were conducted regarding the emerging research of the wheat stem sawfly, and five private farm and ranch consultations were provided by faculty from our Western Triangle Research Center.

The IPM instructors shared sustainable ag practices that will better manage diseases, insects, weeds and rodents. The training also focused on the safest and most effective ways to use

pesticides.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

#### Outcome #2

##### 1. Outcome Measures

New IPM options discovered, evaluated, or changed/altered

##### 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)**

Invasive plant species are recognized as a serious and threatening problem to Montana. Producers must continually improve pest management programs to increase productivity and profit. Consumers are demanding farmers use less chemical pesticides for food crops. Integrated pest management research also involves pest mitigation with researchers investigating both herbicides and biological control agents for insect and plant diseases. Invasive plant species are a serious economic and ecological problem for range and forested lands

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

MSU COA researchers are exploring biological control agents several species of invasive weeds that a negative impact on the state's food production. Research projects contributed to the selection of potential new control agents and an increased understanding of how to use them. They continued exploring targeted sheep grazing as an economical and ecologically sustainable tool to manage lands with large infestations of invasive plants. Numerous biocontrol agents are currently being studied for the control of noxious pests, as many target weeds currently either are

without any form of biological control, or agents already established are not effective over the range of the production.

### **Results**

Researchers released 20 gall wasps in 2009 and found an equal number of galls infesting the Russian knapweed. Since then the numbers have increased exponentially with thousands of galls present in 2013. Additionally, a cost-benefit ratio is being researched to provide information to growers about the use of biological based pesticides for the control of the wheat stem sawfly.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

## **Outcome #3**

### **1. Outcome Measures**

Number of broad-ranging stewardship practices implemented

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

- 1862 Research

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

Change in Condition Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2013	0

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

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

Weed and insect control is critical to sustainable agriculture in Montana. As the climate changes, Montana is dealing with an increase in noxious weeds, rodents, and harmful insects that impact rangeland and cropland.

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

Investigators focus on broad-ranging stewardship practices and emphasized quality educational programs for farmers and ranchers and other key stakeholders. Weed and insect experts traveled throughout the State offering courses on insect and weed identification, proper pesticide usage,

and suggestions for targeted grazing practices. Researchers also made significant advancements in wheat stem sawfly research. Advancements were also made toward integrating molecular research with applied entomology.

### Results

New online information programs are including more data to assist farmers and ranchers with weed and insect identification, including multiple trainings for the United States Forest Service and the Crow Reservation in Montana on identifying rush skeletonweed root moth, and the biological control of weeds and use of insect biocontrol agents. Many radio interviews were conducted regarding the emerging research of the wheat stem sawfly, and five private farm and ranch consultations were provided by faculty from our Western Triangle Research Center. Map models were also created for public use regarding the probability of invasive plant distribution, for specific management areas. This models can be found at: <http://ippf.msu.montana.edu/>

## 4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

## Outcome #4

### 1. Outcome Measures

Passing rate percentage for pesticide application licenses

### 2. Associated Institution Types

- 1862 Research

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

Year	Actual
2013	32

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

Pesticide application training is important for disseminating new data and guidelines. The COA and the Extension Service work closely offering training and application licenses throughout

Montana.

### **What has been done**

MSU Pesticide Education Program administered a website which included 250 private applicator programs this year. These programs are meticulously reviewed before awarding continuing education credits awarded based on meeting the core pesticide education categories: pesticide laws, integrated pest management, calibration, pesticides in the environment, the private applicator license, and pesticide safety. Without available credits private applicators may choose to spray pesticides without adequate training, or to not manage noxious weeds and insect pests through the use of pesticides. A hands-on workshop for 18 Crop Consultants and county extension agents on plant disease diagnosis and management included virus detection. The workshop provided 16 ACA credits and six Montana Private Applicator Credits.

### **Results**

A total of 55 pesticide education presentations were delivered to 2,000 certified applicators across Montana at 42 locations. Presentations included topics of pesticides in the environment, IPM, calibration, pesticide safety, restricted use recordkeeping, mixing and handling, alfalfa weevil IPM, and pesticide poisonings. Fumigant education training targeted 150 applicators with an intense six hours of training. Two train-the-trainer programs targeted 50 local pesticide education trainers. There are approximately 6,600 private applicators this year in Montana.

Thirty-two applicators indicated they would change their behaviors as a result of the education. Changes included applicators protecting themselves and calibrating more often.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

## **Outcome #5**

### **1. Outcome Measures**

New products registered.

Not Reporting on this Outcome Measure

## **Outcome #6**

### **1. Outcome Measures**

Number of potential products/practices evaluated

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

- 1862 Research

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

Change in Action Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2013	19

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

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

Producers and researchers are evaluating new integrated pest management (IPM) methodologies for controlling pests so they can maintain a competitive position in U.S. and world markets while helping to alleviate global hunger. It is important to develop new strategies in order for the pests to not develop resistance.

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

Investigators evaluated biological control agents like *Muscodor albus*, a plant-swelling fungus, to treat diseases in potato and sugar beet crops. This biological control agent has the potential to replace harmful and toxic biocides currently used in agriculture. Continued evaluating targeted grazing and explored other biological control agents.

#### **Results**

MSU COA IPM experts traveled extensively to deliver educational outreach related to cropland entomology. They wrote more than 20 Ag Alerts and several articles in regional magazines, educated growers about current infestations and outbreaks, and posted educational modules on the extension webpage. They also coordinated and distributed 2000 copies of a Pulse Pest Calendar in Montana and North Dakota to growers and agricultural professionals. Additional products produced include: study guide for MSU students was produced, a new germplasm, survey instruments, models, data and research material, weed workshops, biological control workshops, a new collection of Montana insects numbering more than 26,000 specimens, a video on pine invasions from the Northern Hemisphere in New Zealand, and models for creating probability of invasive plant distribution maps for specific management areas.

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

<b>KA Code</b>	<b>Knowledge Area</b>
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211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

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

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

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

##### **Brief Explanation**

The demands of producers who grow crops organically require innovative pest and fertility solutions often requiring biocontrols and alternative nitrogen sources. Organic farming and the introduction of non-traditional crops create a need for MSU researchers to delve into new approaches to crop management.

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

##### **Evaluation Results**

Investigators with the COA and MAES focused on identifying and managing weeds, insects, and diseases, so the agricultural community in Montana can better impact global food security. Field crops are an important foundation for the Montana agricultural industry and revenue exceeding \$2 billion in 2013. The most significant crop in Montana was wheat (5.4 million acres, \$1.4 billion) followed by barley (760,000 acres, \$143 million). The grain supports the livestock industry in Montana, and also the export market. A leading researcher shared that of the growers attending conferences on disease management and fungicide treatment options 65 percent could better identify diseases and had a clearer plan of how to treat them. Educating one field agronomist about stripe rust is estimated to have impacted 48,000 acres with an economic benefit to growers of \$4 million. A direct economic impact of recommendations from researchers at the MSU Schutter Diagnostic lab this year was approximately \$400,000 on 354,000 acres. Requests for assistance were lower, because it was a dry year with fewer disease outbreaks.

Researchers are investigating the sawfly's chemical ecology, and evaluating host plant resistance, pathogens, and cropping strategies. Researchers at MSU identified sex pheromones from hundreds of moth species and are using them to study and trap the insects and disrupt their mating by altering the odorant receptor proteins from male moth antenna. Additionally, studies were aimed at developing microbial pesticides as practical tools for the wheat stem sawfly.

Researchers are better understanding the diversity, distribution, and activities of pollinators (including alfalfa leafcutter bees) in natural and agricultural ecosystems. The goal is to better understand the value of pollinators and predatory insects in agricultural

and natural ecosystems, the effect of land management practices on these insects, and their basic biology.

Integrated management of rangeland invasive plants is also critical. Economically, weeds impact rangeland more than all other pests combined, including billions of dollars spent on control and reduction in livestock and wildlife carrying capacity. Containing existing populations and restoring rangeland severely degraded by weeds is critical for the ecology and economics of Montana agriculture. This year two studies focused on cheatgrass and how to control it as well as revegetation methodologies. Information was shared through workshops and field days with private and public land managers to improve rangeland health.

### **Key Items of Evaluation**

Scientists introduced three new insects into Montana for controlling Russian knapweed and orange hawkweed: *Jappiella ivannikovi* (a gall midge) and two stem galling wasps. Researchers released 20 gall wasps in 2009 and found an equal number of galls infesting the Russian knapweed. Since then the numbers have increased exponentially with thousands of galls present in 2012.

Researchers at MSU identified the molecular basis for evolving ligand specificity of a sex pheromone receptor. This data assisted in advancing the research toward better attacking the wheat stem sawfly with odor traps and other devices.

An important finding in 2013 was the confirmation of glyphosate-resistant kochia populations in Montana. Kochia is especially troublesome in wheat-fallow cropping systems, because it spreads quickly. Researchers are working with farmers in Montana to educate them on herbicide-resistant kochia management.

Research findings this year supported the suggestion that August is the optimal time to prescribe sheep grazing for spotted knapweed. The increased consumption of the knapweed in August versus July suggested either the knapweed was preferred in August or the ewes were becoming adapted to it.