

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

**Program # 5**

**1. Name of the Planned Program**

Plant Production Systems

**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	0%		10%	
202	Plant Genetic Resources	4%		0%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	3%		10%	
205	Plant Management Systems	54%		20%	
206	Basic Plant Biology	9%		10%	
211	Insects, Mites, and Other Arthropods Affecting Plants	6%		10%	
212	Pathogens and Nematodes Affecting Plants	0%		10%	
213	Weeds Affecting Plants	10%		10%	
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	1%		0%	
215	Biological Control of Pests Affecting Plants	1%		10%	
216	Integrated Pest Management Systems	12%		10%	
	<b>Total</b>	100%		100%	

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

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

Year: 2010	Extension		Research	
	1862	1890	1862	1890
Plan	15.0	0.0	26.0	0.0
Actual	17.7	0.0	18.5	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
368850	0	1355064	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
368850	0	1355064	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
882834	0	8247783	0

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

**1. Brief description of the Activity**

- Conduct basic and applied research in plant production systems;
- Provide workshops and educational classes for producers;
- Utilize demonstration plots and field days to communicate program results;
- Use individual counseling with producers and clientele on specific plant production problems.

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

Individual agricultural producers, homeowners, agribusinesses, and commodity organizations.

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

**1. Standard output measures**

2010	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Plan</b>	50000	250000	0	0
<b>Actual</b>	64041	276220	557	0

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

**Patent Applications Submitted**

Year: 2010  
 Plan: 0  
 Actual: 2

**Patents listed**

Plant Variety Protection - Wheat variety Snowmass  
 Plant Variety Protection - Potato Variety Rio Grande Russet

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

**Number of Peer Reviewed Publications**

2010	Extension	Research	Total
Plan	5	25	
Actual	37	206	243

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

**Output Target**

**Output #1**

**Output Measure**

- Release of technologies adopted by growers such as crop cultivars, crop germplasm, or components of crop production systems.

Year	Target	Actual
2010	2	29

**Output #2**

**Output Measure**

- Number of attendees at workshops/trainings/field days.

Year	Target	Actual
2010	10000	14986

**Output #3**

**Output Measure**

- Amount of grant dollars garnered to support natural plant production systems research and outreach.

Year	Target	Actual
2010	250000	1648007

**Output #4**

**Output Measure**

- Technical publications in the topical area of plant production systems.

Year	Target	Actual
2010	25	37

**Output #5**

**Output Measure**

- Number of basic and applied research efforts in plant production systems: Number of

workshops, educational classes for producers Number of demonstration plots and field days  
 Number of individual consultations

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2010	50	0

**Output #6**

**Output Measure**

- Number of Extension workshops focusing on plant production systems.

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2010	50	537

**Output #7**

**Output Measure**

- Number of volunteers supporting plant production systems work.

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2010	200	671

**Output #8**

**Output Measure**

- Number of newsletters distributed in support of this plan of work.

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2010	100	79

**Output #9**

**Output Measure**

- Number of agencies partnering in this work.

<b>Year</b>	<b>Target</b>	<b>Actual</b>
2010	{No Data Entered}	89

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

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

O. No.	OUTCOME NAME
1	Percent of participants at workshops/trainings/field days indicating an increase in knowledge gained.
2	Percent of participants indicating change in behavior/best practices adopted.
3	Economic impact of the change in behavior reported.
4	Adoption of crop production technology as measured by agricultural statistics.
5	Adoption of improved wheat cultivars.
6	Potential of living mulches to decrease soil erosion.
7	Determining Consumptive Water Use in Crops by Direct Measurement of ET
8	Advances in the Development of Wheat Cultivars and Germplasm
9	Advances in Development of Potato Cultivars
10	Adoption of Herbaceous and Woody Plant Species in the Rocky Mountain and High Plains Region
11	Fruit and Vegetable Production Practices to Improve Returns to Growers
12	Improving Acceptance of Certified Potato Cultivars
13	Ecology, Biology and Management of Invasive Weeds in Colorado
14	Ecology of Pests and Pest Management Systems

## **Outcome #1**

### **1. Outcome Measures**

Percent of participants at workshops/trainings/field days indicating an increase in knowledge gained.

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

- 1862 Extension
- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	50	87

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

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

Wheat research and Extension activities contribute significantly to the profitability and sustainability of wheat production in Colorado, which is a key component of the state's rural economy.

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

1. Conduct, report and disseminate the results of the Colorado wheat variety trials.
2. Conduct, report and disseminate the results of the Colorado On-Farm Collaborative Tests (COFT).
3. Survey variety trial cooperators, COFT cooperators, and other key members of the Colorado wheat industry regarding the value of these tests, potential test improvements, and other issues that should be addressed by the Wheat Team.

#### **Results**

87% of participants surveyed reported knowledge gained in wheat best management practices and/or crop production strategies.

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

<b>KA Code</b>	<b>Knowledge Area</b>
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants

- 215 Biological Control of Pests Affecting Plants
- 216 Integrated Pest Management Systems

## **Outcome #2**

### **1. Outcome Measures**

Percent of participants indicating change in behavior/best practices adopted.

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

- 1862 Extension
- 1862 Research

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

Change in Action Outcome Measure

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

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	50	64

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

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

Wheat research and Extension activities contribute significantly to the profitability and sustainability of wheat production in Colorado, which is a key component of the state's rural economy.

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

1. Conduct, report and disseminate the results of the Colorado Wheat Variety Trials (COFT).
2. Conduct, report and disseminate the results of the Colorado On-Farm Collaborative Tests.
3. Survey variety trial cooperators, COFT cooperators, and other key members of the Colorado wheat industry regarding the value of these tests, potential test improvements, and other issues that should be addressed by the Wheat Team.

#### **Results**

63.9% of surveyed farmers are using a multi crop, wheat based cropping system. Additionally, the following indicators provide evidence that farmers are protecting soil health and the environmental quality of farms and surrounding agricultural areas:

74% of survey respondents are using conservation tillage or no-till farming practices

76% of survey respondents use herbicides for weed control every year. The remainder use another form of integrated weed management

70.3% of survey respondents are managing insects on an economic threshold basis.

52.9% of survey respondents manage wheat diseases when conditions justify pesticides.

34.2% of survey respondents apply phosphorus and 39.8% apply potassium and/or micronutrient

#### 4. Associated Knowledge Areas

<b>KA Code</b>	<b>Knowledge Area</b>
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

#### **Outcome #3**

##### 1. Outcome Measures

Economic impact of the change in behavior reported.

##### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

##### 3a. Outcome Type:

Change in Condition Outcome Measure

##### 3b. Quantitative Outcome

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	450000	12000000

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

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

Wheat research and Extension activities contribute significantly to the profitability and sustainability of wheat production in Colorado, which is a key component of the state's rural economy.

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

1. Conduct, report and disseminate the results of the Colorado wheat variety trials.
2. Conduct, report and disseminate the results of the Colorado On-Farm Collaborative Tests (COFT).
3. Survey variety trial cooperators, COFT cooperators, and other key members of the Colorado wheat industry regarding the value of these tests, potential test improvements, and other issues that should be addressed by the Wheat Team.

**Results**

Wheat farmers benefiting from CSU's efforts are equal to \$26,500/farm or \$12 million for all of Colorado's wheat producers each year.

**4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

**Outcome #4**

**1. Outcome Measures**

Adoption of crop production technology as measured by agricultural statistics.

Not Reporting on this Outcome Measure

**Outcome #5**

**1. Outcome Measures**

Adoption of improved wheat cultivars.

**2. Associated Institution Types**

- 1862 Extension
- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	0	95

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

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

Wheat research and Extension activities contribute significantly to the profitability and sustainability of wheat production in Colorado, which is a key component of the state's rural economy.

### **What has been done**

1. Conduct, report and disseminate the results of the Colorado Wheat Variety Trials.
2. Conduct, report and disseminate the results of the Colorado On-Farm Collaborative Tests (COFT).
3. Survey variety trial cooperators, COFT cooperators, and other key members of the Colorado wheat industry regarding the value of these tests, potential test improvements, and other issues that should be addressed by the Wheat Team.

### **Results**

The following indicators provide evidence that farmers are protecting soil health and the environmental quality of farms and surrounding agricultural areas:

- 1.74% of survey respondents are using conservation tillage or no-till farming practices
- 2.76% of survey respondents use herbicides for weed control every year. The remainder use another form of integrated weed management
- 3.70.3% of survey respondents are managing insects on an economic threshold basis.
- 4.52.9% of survey respondents manage wheat diseases when conditions justify pesticides.
- 5.34.2% of survey respondents apply phosphorus and 39.8% apply potassium and/or micronutrients only when needed.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants

## **Outcome #6**

### **1. Outcome Measures**

Potential of living mulches to decrease soil erosion.

Not Reporting on this Outcome Measure

## **Outcome #7**

### **1. Outcome Measures**

Determining Consumptive Water Use in Crops by Direct Measurement of ET

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

- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	{No Data Entered}	0

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

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

Accurate determination of crop evapo-transpiration (ET) is essential in farm irrigation management and administration of water rights in entire river basins of Colorado. Resolution of the Colorado/Kansas water dispute in particular, is dependent on accurate ET determination in the Arkansas River Valley in Colorado.

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

Direct measurements of alfalfa ET were obtained during 4 harvest cycles in 2010 from a precision weighing lysimeter in the Arkansas River Valley of Colorado. Irrigation, crop growth, and soil water balance data from 3 corn fields and 1 alfalfa field in Eastern Colorado were collected. The data from these fields were used in preliminary testing of a spreadsheet-based irrigation scheduling tool that uses daily estimates of crop ET and soil water content to determine the timing and amount of irrigation. One fact sheet describing the water balance approach of irrigation scheduling was also written.

#### **Results**

: Data from the 2008 and 2009 alfalfa growing seasons were analyzed and presented to various water professionals in Colorado. This resulted in 215 individuals learning about how crop coefficients are developed and how they can be used with ASCE standardized reference ET to estimate the ET of different crops. Alfalfa crop coefficient curves for 4 cutting cycles were developed. These locally developed curves can be used with reference ET calculated from the ASCE standardized equation that is being widely adopted in Colorado.

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

**KA Code**    **Knowledge Area**  
205            Plant Management Systems

**Outcome #8**

**1. Outcome Measures**

Advances in the Development of Wheat Cultivars and Germplasm

**2. Associated Institution Types**

- 1862 Research

**3a. Outcome Type:**

Change in Condition Outcome Measure

**3b. Quantitative Outcome**

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	{No Data Entered}	0

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

**Issue (Who cares and Why)**

The objectives of the wheat breeding project are to a) develop wheat cultivars and germplasm having desirable agronomic, disease and insect resistance, and end-use quality characteristics and b) conduct research to improve understanding of genetic and environmental factors that affect wheat yield and end-use quality in Colorado. Development of improved wheat cultivars serves the wheat industry in Colorado by reducing wheat production costs, reducing pesticide use, and providing improved marketing options.

**What has been done**

In fall 2010, three hard red winter wheat (HRW) experimental lines were advanced for Foundation seed production to enable release as new cultivars in fall 2011. All three lines have shown excellent yield and test weight in field trials and good stripe rust resistance. Two of the lines have excellent milling and baking quality. Several other lines under breeder seed increase in 2010 were retained for testing and possible release. To address various pest and production constraints, diverse germplasm sources continue to be used in the crossing program. These include several sources of resistance to wheat rusts, Russian wheat aphid biotype 2, wheat streak mosaic and Triticum mosaic viruses.

**Results**

Since inception of the program in 1963, the CSU Wheat Breeding Program has released over 29 improved wheat cultivars. CSU-bred wheat cultivars account for over 60% (or 72% of the accounted-for acreage) of Colorado's 2.45 million acres (2010 crop) with the remaining acreage planted mostly with cultivars from university breeding programs in adjacent states. Since inception of the program, average wheat grain yields in Colorado have more than doubled with at least 50%

of this increase attributed to improved cultivars. While the value of these yield increases varies according to market prices, estimates of economic returns from two of our most widely grown releases (Hatcher and Ripper) are approximately \$32.3 million for the 2010 crop alone (estimated \$21.9 million for yield improvement and \$10.3 million for quality improvement). As a whole, estimates from Colorado wheat industry leaders on CSU-developed quality improvements suggest that end-use quality enhancements from cultivars developed at CSU provide an average of \$17.5 million per year increased income for Colorado wheat producers (70 million bushels average x \$0.25 per bushel price increase; 2010 dollars).

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants

#### Outcome #9

##### 1. Outcome Measures

Advances in Development of Potato Cultivars

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Condition Outcome Measure

##### 3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	0

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

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

The major objectives of the Colorado Potato Breeding and Selection Program are: (1) to develop new potato cultivars (russets, reds, chippers, and specialties) with increased yield, improved quality, improved nutritional characteristics, resistance to diseases and pests, and tolerance to environmental stresses; (2) to collaborate with growers, shippers, processors, and research personnel to assess the production, adaptability, marketability, and other characteristics of advanced selections from the Colorado program; (3) to provide a basic seed source of selections to growers for seed increase and commercial testing; (4) to evaluate promising selections for potential seed export (interstate and international).

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

Fifty-five advanced selections were saved and will be increased in 2011 pending results of ongoing evaluations. Advanced selections evaluated in the Southwest Regional Trials, Western Regional Trials, or by Colorado producers in 2010, included 6 russets, 2 reds, 9 chippers, and 8 specialties. Consideration is being given to releasing CO95051-7W. This round white selection has excellent chip color after long term storage. Plant Variety Protection was granted to Rio Grande Russet in 2010.

#### **Results**

: Since 1975, there have been 27 potato cultivars/clonal selections released by Colorado State University or in cooperation with other agencies. Colorado State University releases accounted for 59% of the 55,500 acres planted to fall potatoes in Colorado in 2010. Colorado cultivars and clonal selections accounted for 44% of the 12,053 acres of Colorado certified seed accepted for certification in 2010. Advanced Colorado selections accounted for another 1% of the seed acreage. Three of the top 10 russet cultivars grown for seed in the U.S. [Canela Russet (#7), Rio Grande Russet (#8), Russet Norkotah-S3 (#9) in 2009 were developed by the Colorado program. Also for reds Sangre-S11 ranked #7. For colored-fleshed specialties, Mountain Rose and Purple Majesty both ranked #1 among red- and purple-fleshed cultivars.

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

<b>KA Code</b>	<b>Knowledge Area</b>
202	Plant Genetic Resources
205	Plant Management Systems

#### **Outcome #10**

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

Adoption of Herbaceous and Woody Plant Species in the Rocky Mountain and High Plains Region

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

- 1862 Research

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

Change in Condition Outcome Measure

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

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	{No Data Entered}	0

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

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

: Select, introduce and evaluate herbaceous annuals, herbaceous perennials and woody plant material for growing in the Rocky Mountain and High Plains Region including Plant Select and

native plant material

### **What has been done**

Woody (64 taxa) and herbaceous plant (52 taxa) were acquired in 2010 for evaluation. Performance records for 3140 taxa of woody and herbaceous plants were entered into a computer system, which are available on three websites. Approximately 1100 varieties of annual flowers and 80 varieties of herbaceous perennials were evaluated in 2010. In 2010, seven plant species were recommended or introduced by Plant Select. A project determining herbaceous plant species and media suitable to support green roofs in a semi-arid area was completed. A performance report for annuals (summer and winter) and perennial trials was published and sent to all cooperators and industry personnel in the state and region.

### **Results**

Specific performance results from these annual, perennial and woody plant trials help determine which new and superior annual and perennial varieties growers throughout the state and region should grow and market. In 2010, over 1.5 million Plant Select plants were sold and over one million people visited the 70 plus demonstration gardens. Many seed and vegetatively propagated varieties including coleus, New Guinea impatiens, pennisetums, spreading petunias and rudbeckias have become important bedding plant crops in the state. Plant Select plants, which are either introductions or recommendations throughout the state and region, means marketing more profitable plants for growers and retailers throughout state and region. Knowledge of exact water requirements of various mesic shrub species will provide property managers and homeowners monetary savings by ultimately conserving water use. Green roofs have been shown to manage storm water, mitigate urban heat island effect and reducing air and noise pollution along with adding esthetics to urban landscapes. Various plant species and growing media can now be recommended for green roofs in a semi arid region.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
213	Weeds Affecting Plants

## **Outcome #11**

### **1. Outcome Measures**

Fruit and Vegetable Production Practices to Improve Returns to Growers

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

- 1862 Research

### 3a. Outcome Type:

Change in Condition Outcome Measure

### 3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	0

### 3c. Qualitative Outcome or Impact Statement

#### Issue (Who cares and Why)

The Arkansas Valley has a long and successful history of vegetable seed production and at one time, provided a significant portion of the cucurbit seeds used in the United States. Although seed production has diminished from its historically high level, there is still a sizable amount of conventional seed production in the Valley. There has been a dramatic increase in organic vegetable production. As a result, demand for organic vegetable seed is growing rapidly as the USDA National Organic Program requires organic farmers to use certified organic seed when available. With this potential, there is an opportunity to re-establish the seed production industry in the Arkansas Valley.

#### What has been done

In 2010, a study was conducted to characterize the fresh market and seed yield response of organically-grown watermelon (Crimson Sweet) to different mulching methods. The methods were bare ground, straw mulch, and black plastic mulch. All treatments were irrigated via drip lines placed under the production bed at a depth of 3 inches. Total marketable fruit yields and seed yields were significantly higher for watermelon grown with black plastic mulch than with straw mulch or with bare ground. The straw mulch treatment had higher fresh fruit yield and seed yield than bare ground but that difference was not significant (lsd=0.1). Relative to the other treatments, weeds were easier to control in the plastic mulch treatment.

#### Results

Gross returns without plasticulture average \$3000 per acre. With plasticulture, gross returns reach \$6000 per acre with approximately \$200 additional cost for plastic or a net marginal income increase of \$2800 per acre.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems

## **Outcome #12**

### **1. Outcome Measures**

Improving Acceptance of Certified Potato Cultivars

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

- 1862 Research

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

Change in Condition Outcome Measure

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

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	{No Data Entered}	0

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

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

Potato Virus Y (PVY) continues to be an ongoing disease threat to the Colorado potato industry. This disease has continued to be epidemic in certain cultivars such as Russet Norkotah and Shepody. Producers, especially certified seed producers, have been having severe difficulties in keeping seed in the certification program because of PVY infection. Additionally, commercial producers have seen a drop in overall yield of larger tubers due to virus infection

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

: Ongoing projects have helped in understanding the way the virus moves between fields and how this movement might be controlled. Growers have been utilizing the findings from these projects to help reduce the overall impact from PVY. During the year, the 'Certified Seed Potato Act' was made law. As a co-author of this legislation, it is expected that significant control of PVY as well as other diseases may be forthcoming due to the planting of all certified seed or at least fully tested seed sources. A poster was presented at the annual National Potato Council Potato Expo as well.

#### **Results**

: Potato growers in Colorado continued, in 2010, to demonstrate significant changes in their production of the most susceptible cultivars, especially Russet Norkotah. This change helped them pass a higher percentage of certified seed than in 2010 because the newer russet cultivars demonstrated less issues with PVY. Additionally, efforts in both demonstration type on-farm projects and during grower meetings resulted in behavioral changes by producers in how they produce the most susceptible cultivars which also reduced loss of seed acreage due to disease issues.

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

<b>KA Code</b>	<b>Knowledge Area</b>
202	Plant Genetic Resources
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

### **Outcome #13**

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

Ecology, Biology and Management of Invasive Weeds in Colorado

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

- 1862 Research

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

Change in Condition Outcome Measure

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

<b>Year</b>	<b>Quantitative Target</b>	<b>Actual</b>
2010	{No Data Entered}	0

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

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

: Yellow toadflax is a creeping perennial weed that is noxious in Colorado and very problematic in the Intermountain West. It is very difficult to control and in our experiments to date, acceptable control was not achieved 1 year after treatments (YAT) were applied and site to site variation has been extreme.

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

Identical experiments were established at 5 sites in 2008 as part of a series of experiments to determine whether site to site variation is genetically or environmentally based. Treatments included chlorsulfuron at 53, 88, and 105 g ai/ha, imazapyr at 140, 280, and 420 g ai/ha, and a non-treated control plot. In 2010, 2 YAT biomass data were collected and yellow toadflax control remained acceptable at 3 of the 5 sites at the 2 highest rates of both herbicides. Control varied with location and unlike in 2009, the site effect was no longer eliminated at the highest rate of either herbicide, which appears to be driven by the 2 low elevation sites. The high rates of control 2 YAT at 3 sites and control breaking down at the 2 low elevation sites strongly suggests that the site to site variation that we have historically observed is environmentally based and not inherited. Enzyme assays also showed no herbicide resistance among the accessions further indicating that the variation is associated with environmental differences among sites.

##### **Results**

The spatial variation associated with using herbicides to control yellow toadflax appears to be environmentally related rather than associated with inheritance. While imazapyr is not a standard recommendation because of limited selectivity, chlorsulfuron is a common recommendation and the site variation vanished at the 2 highest rates in 2010 albeit, control was only commercially acceptable at 3 of 5 sites. Imazapyr, however, is used by public land managers to control yellow toadflax near water and clearly, the 280 and 420 g ai/ha eliminated site variation. Chlorsulfuron at 88 g ai/ha will remain a common recommendation to control yellow toadflax in Colorado. This information will be shared with public land managers and private land owners in Colorado. Some public land managers in particular have been using tank mixes with three to four different herbicides to control yellow toadflax and our results demonstrate that populations of this troublesome invasive weed can be decreased effectively by using less total herbicide. Adoption of our results also will decrease injury to desirable forbs and shrubs by using less herbicide, which should lessen re-invasion potential by the same or other weedy forbs.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
213	Weeds Affecting Plants

#### Outcome #14

##### 1. Outcome Measures

Ecology of Pests and Pest Management Systems

##### 2. Associated Institution Types

- 1862 Research

##### 3a. Outcome Type:

Change in Condition Outcome Measure

##### 3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	{No Data Entered}	0

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

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

Arthropods are important food sources in terrestrial food webs, and understanding what influences patterns of diversity and abundance of these species is essential for developing informed management practices in natural systems. Of particular importance is determining what impact non-native species such as tamarisk have on arthropod abundance and diversity, and what impact control strategies for tamarisk (such as biological control) have on food web structure.

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

: In 2010, scientists and managers from the National Park Service, State and County agencies, scientists from the Entomological Society of America, students from Colorado State University all received information on the impact of toadflax and tamarisk biological control on target and non-target species. Results from this project were published in one peer reviewed journal article and three management handbook chapters.

### **Results**

Transmittal of this knowledge has led to a change in conditions, informing scientists and resource managers of the target and non-target impacts of biological control systems of toadflax, tamarisk and other weeds. Increased knowledge of these impacts will allow policy makers and resource managers to make more informed decisions on invasive plant management and biological control strategies.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants

## **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 Programmatic Challenges

### **Brief Explanation**

The external factors marked above would cause changes in programming and the time Extension Agents and Specialists could devote to any specific program or topic. A natural disaster, such as drought, would require additional programming to provide the education and information producers would need for their businesses to survive. Decreases in appropriated budgets, county and/or state, would likely force agents to alter their work on cropping issues. Members of the Work Teams associated with Plant Production Systems would tailor the topics presented in workshops, change educational programming, and/or develop new or different technologies and strategies for crop producers if there were changes in government regulations.

## **V(I). Planned Program (Evaluation Studies and Data Collection)**

### **1. Evaluation Studies Planned**

- After Only (post program)
- Before-After (before and after program)
- During (during program)
- Case Study

## **Evaluation Results**

- 95% of Colorado wheat farmers surveyed are convinced that they have benefited from CSU developed wheat varieties and Extension education efforts equal to \$22.50/acre.
- Wheat farmers benefiting from CSU's efforts is equal to \$26,500/farm or \$12 million for all of Colorado's wheat producers each year.

## **Key Items of Evaluation**

The work of the NIFA priority area 'Global Food Security and Hunger' of necessity includes both animal and plant production systems and integrates Extension education in disseminating research results.

- Translate basic research and conduct applied research in animal and plant production systems;
- Deliver workshops and educational classes for producers;
- Communicate results through demonstration plots and field days;
- Provide individual counseling for producers and clientele on specific animal and plant production problems.