V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Plant Production Systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	0%		4%	
103	Management of Saline and Sodic Soils and Salinity	0%		7%	
111	Conservation and Efficient Use of Water	0%		5%	
121	Management of Range Resources	0%		9%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		5%	
202	Plant Genetic Resources	0%		7%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		6%	
205	Plant Management Systems	30%		6%	
206	Basic Plant Biology	0%		3%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		0%	
212	Pathogens and Nematodes Affecting Plants	10%		0%	
213	Weeds Affecting Plants	10%		3%	
215	Biological Control of Pests Affecting Plants	10%		0%	
216	Integrated Pest Management Systems	30%		13%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	0%		9%	
403	Waste Disposal, Recycling, and Reuse	0%		5%	
405	Drainage and Irrigation Systems and Facilities	0%		10%	
502	New and Improved Food Products	0%		4%	
601	Economics of Agricultural Production and Farm Management	0%		2%	
605	Natural Resource and Environmental Economics	0%		2%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	15.0	0.0	26.0	0.0
Actual Paid Professional	13.9	0.0	19.7	0.0
Actual Volunteer	10.5	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
247441	0	1005412	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
247441	0	1005412	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
575994	0	10673520	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Extension reports activities from three work Teams in this section, including Pest Management (PM) , Small Farms and Specialty Crops (SFSC), and Wheat-Based and Other Cropping Systems (WOCS).

- Conduct basic and applied research in plant productions systems.
- 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.

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	178140	273838	2038	322

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

Patent Applications Submitted

Year: 2012

Actual: 3

Patents listed

Potato selections to be named are AC99329-7PW/Y (Masquerade), CO99053-3RU (Crestone Russet), CO99100-1RU (name to be determined).

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	33	157	190

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of new technologies released
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

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

Year	Actual
2012	13893

Output #3

Output Measure

- Amount of grant dollars garnered to support natural plant production systems research and outreach.
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Number of Extension workshops focusing on plant production systems.

Year	Actual
2012	862

Output #5

Output Measure

- Number of volunteers supporting plant production systems work.

Year	Actual
2012	37

Output #6

Output Measure

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

Year	Actual
2012	195

Output #7

Output Measure

- Number of workshops, educational classes for producers
  Not reporting on this Output for this Annual Report

Output #8

Output Measure

- Number of demonstration plots and field days
  Not reporting on this Output for this Annual Report

Output #9

Output Measure

- Number of individual consultations
  Not reporting on this Output for this Annual Report

Output #10

Output Measure

- Number of agencies partnering in this work
  Not reporting on this Output for this Annual Report

Output #11

Output Measure

- Field crop acreage under crop and soil management systems that result in an enhancement of soil health and crop productivity (including but not limited to no-till or conservation tillage practices).

Year	Actual
2012	130

Output #12

Output Measure

- Farmed acreage planted to diversified cropping systems.

Year	Actual
2012	175

Output #13

Output Measure

- Farmed acreage managed with research-based best management practices for water-use crop efficiency.

Year	Actual
2012	66

Output #14

Output Measure

- Greenhouse irrigation technology

Year	Actual
2012	0

Output #15

Output Measure

- Adaption of new potato varieties

Year	Actual
2012	0

Output #16

Output Measure

- Management of potato plant pathogens

Year	Actual
2012	0

Output #17

Output Measure

- Adoption of improved wheat cultivars

Year	Actual
2012	0

Output #18

Output Measure

- IPM legume pipe

Year	Actual
2012	0

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 improved wheat cultivars.
5	Participants improve or intend to improve their practices, decisions and skills in action through timely access to pest management resources and/or pest identification and IPM implementation.
6	Participants will gain/increase knowledge/literacy in pest diagnostics and pest management.
7	Participants have accessed resources, information and networks to improve their production enterprises
8	Adoption of improved wheat cultivars
9	Green house irrigation technology
10	Adoption of new potato varieties
11	Management of potato plant pathogens
12	IPM Legume pipe

Outcome #1

1. **Outcome Measures**

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

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

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

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Economic impact of the change in behavior reported.

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Adoption of improved wheat cultivars.

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

   Participants improve or intend to improve their practices, decisions and skills in action through timely access to pest management resources and/or pest identification and IPM implementation.

2. **Associated Institution Types**

   - 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	90816

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One example: Onion production across the United States has been impacted by Iris Yellow Spot Virus (IYSV) which is vectored by the onion thrips (Thrips tabaci). Reducing thrips populations can sometimes help reduce infection rate of IYSV in onions. In Colorado, companion crops (living mulch) such as barley and spring wheat planted with onions to reduce wind and water erosion, has sometimes had an effect on thrips populations.

What has been done
Both of the Northern Colorado Onion Variety Field Trial locations were harvested and processed during the month of September. The Sakata location was harvested on 9/14 and processed on 9/17. The Winter location was harvested on 9/19 and processed on 9/20. During processing, onions were checked for size, disease and the number of double centers along with yield.

Results
Results from these trials are sent to onion seed companies, onion producers and onion researchers. Onion producers use this information to help them decide which onion varieties they will plant next spring. Onions are a $50 million dollar crop here in Colorado. Colorado State University Extension onion research is valued by the Colorado Onion Association and onion growers across Colorado. Extension's research has led to greater yields and higher quality of onions which positively impacts the onion producer's bottom line.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

Participants will gain/increase knowledge/literacy in pest diagnostics and pest management.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1870

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A conservative loss estimate of 5% to 10% due to plant pests could cost Colorado producers in urban and rural settings $50 to $100 million annually.

What has been done
Components include identifying the pest, understanding the life cycle and biology of the pest, and selecting appropriate, timely and economical pest management strategies. The Tri River Area insect diagnostic lab identified more that 500 insect samples, 80% from the TRA, with the remainder mostly from the western region counties. These are samples not reported by Master Gardeners. Many are home and structural pests, and many have direct impact on human and animal healh. The lab receives bedbug, flea, conenose and many suspected biting arthropod samples, which are identified to species if necessary. The TRA lab is a primary identification source for for many pest management professionals in western Colorado when they get unique samples that need positive identification.

Results
Client comments are overwhelmingly positive: "There is no other reliable public source for insect identification in western Colorado."

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #7

1. Outcome Measures

Participants have accessed resources, information and networks to improve their production enterprises

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	750

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Commercial producers seek to attain their business goals and improve their business management and practices.

What has been done
Colorado farmers and ranchers have increased access to resources, information and networks to improve their production enterprises.

Results
Community development activities link with content expertise to help clients make good decisions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

Outcome #8

1. Outcome Measures

Adoption of improved wheat cultivars

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2012 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Development of improved wheat cultivars serves the wheat industry in Colorado and the western Great Plains by reducing wheat production costs, reducing pesticide use, and providing improved marketing options.

What has been done
In fall 2012, experimental line CO07W245 was released as 'Antero'. Antero is a hard white winter wheat (HWW) from the cross KS01HW152-1/TAM 111 made in 2003. Antero is medium height and medium maturing, and has a medium-length coleoptile, good straw strength, and excellent test weight. Pre-harvest sprouting tolerance of Antero is similar to Snowmass, which is similar to Hatcher hard red winter wheat (HRW). Antero is resistant to stripe rust, moderately resistant to stem rust and wheat soilborne/wheat spindle streak mosaic virus, moderately susceptible to barley yellow dwarf and wheat streak mosaic viruses, and susceptible to leaf rust and all biotypes of Russian wheat aphid. Antero was the second highest yielding entry in the trials, similar to Byrd HRW.

Results
Since inception of the program, 36 CSU-bred wheat cultivars account for 61.3% (or 77.4% of the accounted-for acreage) of Colorado's 2.4 million acres (2012 crop). Average wheat grain yields in Colorado have more than doubled with at least 50% of this increase attributed to improved cultivars. Estimates of economic returns in Colorado from CSU-developed wheat varieties were approximately $43 million for the 2011 crop alone. These estimates include yield increases resulting from improved CSU varieties ($29 million), marketing benefits resulting from CSU varieties with enhanced end-use quality ($9 million), and yield-protection resulting from adoption of CSU varieties carrying herbicide tolerance traits for winter annual grassy weed control ($5 million).

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems

Outcome #9

1. Outcome Measures

Green house irrigation technology

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The US greenhouse and nursery industry supplies consumers with ornamental plants, vegetable seedlings, and fruit trees for use in gardens throughout North America. Irrigation in greenhouses and nurseries can be difficult to manage, because many of the plants are grown in fairly small pots that may need to be watered several times per day. Most greenhouse and nurseries grow a wide variety of crops; adjusting irrigation of all these crops based on the actual watering needs is too time-consuming for growers.

What has been done
A nursery loses about 20 - 30% of the plants during the production, and most of these losses are due to watering too much. We have developed wireless sensor networks to help growers automate irrigation based on the actual water needs of their crops. The principle is simple: soil moisture sensors are inserted into the pots and they measure how much water is present. The sensors are connected to a node, which radios the data to a computer, where the data is presented in charts. Growers can see whether the various crops have adequate water. They can use this computer to instruct each node when and for how long to turn on the irrigation. Using the wireless sensor networks to automate the irrigation of the crop can eliminate these losses.

Results
The precision irrigation had various benefits to the nursery: since none of the plants died because of overwatering, the nursery could sell more plants than they anticipated. And shortening the production cycle reduced the production inputs (labor, fertilizer, pesticides). The required hardware only costs about $6,000, so the return on investment was just a few months. This research not only benefits the nurseries, but also society at large: by irrigation more precisely, nurseries can withdraw less ground water, leaving more water for other uses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
205	Plant Management Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #10

1. Outcome Measures

Adoption of new potato varieties

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The major objectives of the Colorado Potato Breeding and Selection Program are to address the needs of Colorado growers to have 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. by assessing production, adaptability, marketability, and other characteristics of advanced selections

What has been done
The primary emphasis is placed on the development of russet cultivars. The balance of the breeding effort is devoted to developing red, specialty, and chipping cultivars. This broad approach is important because it recognizes the diverse markets accessed by potato growers throughout Colorado and many other states in the region. Seventy-five advanced selections were saved and will be increased in 2013 pending results of ongoing evaluations. Twelve advanced selections were evaluated in the Southwest Regional Trials, Western Regional Trials, or by Colorado producers in 2012. Several selections are being considered for exclusive release. Selections to be named are AC99329-7PW/Y (Masquerade), CO99053-3RU (Crestone Russet), CO99100-1RU (name to be determined).

Results
Since 1975, there have been 27 potato cultivars/clonal selections released by Colorado State University (CSU) or in cooperation with other agencies. CSU releases accounted for 58% of the 55,100 acres planted to fall potatoes in Colorado in 2012. Colorado cultivars and clonal selections accounted for 46% of the 13,286 acres of Colorado certified seed accepted for certification in 2012. Three of the top 10 russet cultivars grown for seed in the U.S. [Russet Norkotah-S3 (#5), Canela Russet (#8), Rio Grande Russet (#10), in 2012 were developed by the Colorado program. For reds, Sangre-S11 ranked #5. For colored-fleshed specialties, Mountain Rose and Purple Majesty both continue to be ranked #1 among red- and purple-fleshed cultivars.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
206	Basic Plant Biology
502	New and Improved Food Products

Outcome #11

1. Outcome Measures

Management of potato plant pathogens

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Powdery scab and early blight have been significant issues for the potato industry in Colorado and the Western U.S. Any one of these disease problems can reduce yield and quality and can have a major influence on a producers yield, quality and ultimately, the marketing of the potato product. Growers need a better understanding of various potato diseases under Colorado conditions and to implement disease suppression control strategies through a best management practices approach.

What has been done

Substantial progress has been made on management and control of powdery scab utilizing a series of integrated steps to inform the producer of potential problems and then use specific strategies to manage and control the disease. The steps include analyzing all of the common cultivars grown within the Colorado potato industry for susceptibility to powdery scab problems, conducting a soil assay using a specific PCR technique to determine the population of spore balls present in any given field, to assist the producer in making good decisions regarding the susceptibility of specific cultivars, planting in the right fields, using chemical controls when warranted, and correctly managing the field production environment to minimize infection by the pathogen.

Results

Iimpacts from this research have been varied and consistently benefited potato producers in Colorado. One impact has been reduction and management of early blight .Ccontrolling early blight utlizing the rotation of chemistries used in this research project coupled with the proper timing of the applications results in a savings to the average producer based on their former practices of over 50%/ha or about $61.75/ha. Producers for at least 5,000 ha of potatoes have indicated that they are using these early blight treatments for an annual savings of $309,000.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

Outcome #12

1. Outcome Measures

IPM Legume pipe

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The IPM Legume PIPE project has evolved in its scope and interactivity with state, regional, and national stakeholders and organizations involved with the production, pest management (emphasis upon IPM strategies including selection of disease resistant varieties, planting clean seed, suitable crop rotation, scouting and confirmation of economic threats from disease organisms and insect pests, and timely application of pesticides as needed) and marketing of legumes (emphasis on non-soybean crops).

What has been done
This project evaluated breeding lines of common beans for resistance to priority diseases including rust and common bacterial blight. The Legume ipmPIPE web site and digital resources will be archived for access by stakeholders and linkage to new USDA-NIFA projects that will include international programs designed to reduce losses from root rot diseases in Africa.

emphasis will be on technology transfer (VegNet and AlliumNet web sites) of pest biology and management to clientele.

Results

The legume industry representing the following non-soybean pulse crops (2000-2009 records from USDA-ERS) has been impacted by the Legume ipmPIPE grant of $350,000 plus participant resources of $500,000 per year with a conservative return of 5 percent ($48 million or an annual Return on Investment of 50 to 1) by reducing losses from diseases and pests affecting: Common Beans - 1,570,000 Acres valued at $461 million, Snap Beans - 100,720 Acres valued at $296 million, Cowpeas - 33,000 Acres valued at $18 million, Lima Beans - 32,000 Acres valued at $29 million, Chickpeas (Garbanzos) - 97,000 Acres valued at $27 million, Lentils - 300,000 Acres valued at $61 million, and Peas (dry, snap) - 560,000 Acres valued at $88 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

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

Colorado's on-line planning and reporting system does not furnish data in percentages. Therefore, all previously planned outcomes noted in percentages are not reported.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Wheat Collaborative On Farm Trials (COFT) - 2012 Evaluation: Extension Agents in Colorado's High Plains region worked with farmer cooperators in conducting the States 32 Collaborative On-Farm Trials (COFT) for wheat in 2012. Jerry Johnson provides leadership for this program. Bruce Bosley, Ron Meyer, John Deering, and Wilma Trujillo, and Thaddeus Gourd provide necessary farmer cooperator contact and variety trial work through the wheat production season (Seed delivery & Planting through final trial harvest). This crew also worked with these same farmers in planting six wheat varieties this fall (2012) in 34 Collaborative Trials across eastern Colorado.

Key Items of Evaluation