V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Natural Resources and Environment

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources	1%		10%	
102	Soil, Plant, Water, Nutrient Relationships	27%		10%	
103	Management of Saline and Sodic Soils and Salinity	1%		10%	
104	Protect Soil from Harmful Effects of Natural Elements	1%		0%	
111	Conservation and Efficient Use of Water	17%		20%	
112	Watershed Protection and Management	2%		10%	
121	Management of Range Resources	18%		10%	
122	Management and Control of Forest and Range Fires	1%		0%	
123	Management and Sustainability of Forest Resources	7%		10%	
131	Alternative Uses of Land	15%		0%	
132	Weather and Climate	0%		10%	
133	Pollution Prevention and Mitigation	3%		0%	
134	Outdoor Recreation	1%		0%	
136	Conservation of Biological Diversity	6%		0%	
403	Waste Disposal, Recycling, and Reuse	0%		10%	
	Total	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	25.0	0.0	11.0	0.0
Actual	24.7	0.0	17.9	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**
516624	0	711985	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
516624	0	711985	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1236528	0	10686430	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

•Conduct workshops and educational classes for producers, landowners, and agency personnel;

•Establish demonstration plots and field days to share research and outreach results;

•Consult with individual producers and landowners to address local problems;
•Conduct basic and applied research on environmental and natural resources issues.

2. Brief description of the target audience

Individual agricultural producers, landowners, homeowners, commodity groups, regulatory agencies, agribusinesses, and local, state, and federal land management agencies.

V(E). Planned Program (Outputs)

1. Standard output measures

2010	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	30000	200000	0	0
Actual	98621	42704	4053	0

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

Patent Applications Submitted

Year: 2010
Plan: 0
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Plan	25	25	
Actual	45	91	136

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Target	Actual
2010	15000	26783

Output #2

Output Measure

- Amount of grant dollars garnered to support natural resources research and outreach.

Year	Target	Actual
2010	250000	695964

Output #3

Output Measure

- Number of technical and refereed journal articles published.

Year	Target	Actual
2010	25	45

Output #4

Output Measure

- Number of Master Gardener and Wildlife Master volunteer hours

Year	Target	Actual
2010	55000	55900

Output #5

Output Measure

- Value of volunteer time at $20/hr (nationally recognized value.)

Year	Target	Actual
2010	1000000	1166000

Output #6

Output Measure

- Number of volunteers supporting this program.

Year	Target	Actual
2010	2000	1731

Output #7

Output Measure

- Number of partnering agencies supporting this program.

Year	Target	Actual
2010	100	228

Output #8

Output Measure

- Number of new technologies adopted by producers.

Year	Target	Actual
2010	10	2

Output #9

Output Measure

- Pounds of food donated to local food banks through Master Gardener efforts.

Year	Target	Actual
2010	40000	32300

Output #10

Output Measure

- Number of curriculum pieces developed and/or reviewed in support of this planned program.

Year	Target	Actual
2010	5	14

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Percent of participants in 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	Reducing cost of irrigation.
5	Impact of UV-B radiation on agriculture.
6	Small acreage management workshops.
7	Crop and Soil Management Systems in Water Limited Agroecosystems
8	Watershed-Scale Planning for Evaluation of Agricultural Conservation Practices
9	Effects of Irrigated Agriculture and Riparian Vegetation on Fish Habitats

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	60	59

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Pest infestations are serious issues endemic to SW Colorado and other areas. Impacts include loss of agricultural and horticultural production; decreasing property values and aesthetics; degradation of the environment and wildlife habitat; loss of desirable plants and native species; tourism impacts; and increasing economic costs of control and mitigation. Specific values and local and/or regional examples include firewood management to reduce pest movement that has become a major issue in North America.

What has been done
Team members monitor for and manage endemic and invasive pests that affect plants, animals and people in agricultural and non-agricultural sectors and economies of Colorado society. We have conducted research and delivered many presentations, and are helping with the State's firewood management plans. Workshops covered the topics of poisonous plants, insect pests, plant diseases, wildlife damage, and tamarisk management.

Results
59% of participants surveyed reported increased knowledge among the following topics:
Pest Diagnosis;
Pest Literacy;
Pest Management Strategies;
Improved Profitability with Timely Pest Management;
IPM Strategies for Crop Systems & Pest Complexes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
123	Management and Sustainability of Forest Resources

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

Year	Quantitative Target	Actual
2010	50	63

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Adequate supplies of clean water are essential to the health and well being of Colorado citizens, agriculture, industry, wildlife and the economic vitality of the state. Agriculture, industry, homeowners and agencies look to Colorado State University Extension to provide research-based information and educational programs on water quality, water quantity, water policy, and other water resource issues.

What has been done
Increasing the awareness and knowledge level of Colorado citizens so they can manage and adapt to the complex and challenging water issues in Colorado. The first step of this strategy is to provide training and resources for CSU Extension staff so they can conduct relevant educational programming that addresses real needs of their constituents. This step is consistent with strategies proposed by Smith and Waskom (2000), 'Key Strategy Elements:1.1 Provide for water education needs of Extension Agents and other CSU personnel involved in outreach programs.'

Results
63% of participants surveyed indicated they had changed behavior/use of skills in one or more of these areas:
Maintaining watershed health; Using deficit irrigation; Following IWM plans resulting in more efficient irrigation water use, greater reductions in salt, selenium, and/or nutrient loads to rivers in

affected areas, reduced nitrate and pesticide loads to groundwater, and more sustainably profitable operations; Beginning to use recommended strategies when farmland is de-watered.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
103	Management of Saline and Sodic Soils and Salinity
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land

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

Year	Quantitative Target	Actual
2010	150000	1232027

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sustainable landscapes use site-appropriate native plants and can reduce the need for water, maintenance time and pesticide use. Research demonstrates that landscapes including natives and adapted non-natives can reduce water usage by 60%. Native plants can also be beneficial because they are environmentally adapted, hardy, provide food and shelter for wildlife and maintain local biological diversity. However, many residents need education in selecting plants appropriate to their state's local environmental conditions such as water availability, soils and elevation.

Invasive, non-native weeds are a critical concern in many communities and threaten native ecosystems. Management of invasive weeds is critical when maintaining a natural space or a landscaped yard and garden. The United States spends $137 billion per year in controlling weeds and mitigating damage. Noxious weeds are moving into valued ecosystems displacing

natives at an alarming rate. Invasive species are a factor in the decline of 49% of all imperiled species. Each year invasive species advance by 1.7 million acres and are found on 133 million acres across the country. In order to reduce cost and impact of invasive weeds, education is required.

What has been done

Educate the public about native plants in order to foster stewardship, sustainable landscaping and management of weeds that threaten native ecosystems.
Native Plant Master(r) courses offered in the field using living examples of the local flora.
Trainers teach identification of native and non-native plant species using dichotomous keys.
Trainers focus on sustainable landscape use of native plants and management strategies for invasive non-native plants.
Courses on public and private lands during spring, summer and fall.

Results

$31,531 was saved by participants' planting of natives in a sustainable landscape (resulting from reduced landscape inputs such as watering, pruning, pest control etc.) $1,200,497 was saved by alien weed control efforts (resulting from improved grazing, crop output, ornamental landscapes, wildlife habitat, tourism, etc.).The figures were acquired through an annual Student Voice Survey of past participants in Native Plant Master courses. The survey includes questions on what actions participants have taken as a result of their participation in the Native Plant Master program.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
121	Management of Range Resources

Outcome #4

1. Outcome Measures

Reducing cost of irrigation.

Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

Impact of UV-B radiation on agriculture.

Not Reporting on this Outcome Measure

Outcome #6

1. **Outcome Measures**

Small acreage management workshops.

Not Reporting on this Outcome Measure

Outcome #7

1. **Outcome Measures**

Crop and Soil Management Systems in Water Limited Agroecosystems

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 purpose of this project is to advance understanding of water limited agroecosystems and develop sustainable management practices. The project is carried out in two major agroecosystems, dryland cropping systems and limited irrigation cropping systems in the semiarid Eastern Plains of Colorado. In dryland cropping, each unit of rainfall is so critical to production, that a practice that conserves an additional inch of water can be the difference between profit and loss.

What has been done

This project is developing dryland cropping systems that improve the capture and use of precipitation with long term ecological sustainability with field research locations at Fort Collins, Iliff, Sterling, Stratton, and Walsh. The studies emphasize intensified crop rotations in no-till based systems and have documented 50-70% annualized grain yield increases over conventional practices. We have reduced consumptive water use by 20-50% while maintaining a similar level on-farm income. In 2010, we statistically determined the CERES-Maize model accurately differentiates between full and limited irrigation corn production in northeastern Colorado in terms of evapotranspiration, crop growth, yield, water use efficiency.

Results

Intensive dryland cropping systems build soil organic carbon, improve soil quality, and improve both air and surface water quality because they provide high amounts of year around cover. These benefits have been realized for about 1,500,000 acres in CO that have been converted from wheat-fallow to wheat-summer crop-fallow. This conversion increased net return by $22,275,000 per year under normal precipitation conditions. Limited irrigation cropping systems based on conservation tillage practices demonstrated in this project build soil organic carbon, improve soil quality, and improve both air and surface water quality because they provide high amounts of year around cover. These benefits have the potential to affect as much as 2,000,000 acres in CO. Survey results from this project document that irrigated farmers in the South Platte River Basin have a willingness to adopt limited irrigation cropping systems and that there will be adequate water savings to meet projected urban water demand through water lease arrangements.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water

Outcome #8

1. Outcome Measures

Watershed-Scale Planning for Evaluation of Agricultural Conservation Practices

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 primary goal of this project is to develop and demonstrate a new technology (the Conservation Impact Assessment Tool, CIAT) that can be used in market-based approaches to evaluate multiple effects (costs and water quality benefits) of commonly adopted agricultural conservation practices or best management practices (BMPs) at both field and watershed scales. The tool will be applicable to evaluate effects of practices to improve both water and soil resources and can be used to establish the basis for nutrient trading/accounting in agricultural watersheds.

What has been done

Several additional conservation practices were added in the tool to incorporate feedbacks from the stakeholder advisory group. Currently, the list of practices includes: crop rotation, field borders, gazing, nutrient management, pesticide management, residue/tillage management, terraces, ponds, wetlands, grassed waterways, filter/riparian strips, bank stabilization structures, grade stabilization structures, sedimentation basins, contour farming, and irrigation. Feedback from the user advisory group was incorporated to modify the input requirements, map production, and output generation components of the tool.

Results

The headwater basins of Colorado are heavily relied upon for freshwater resources on an annual basis. However, knowledge concerning both generation of such resources, and implications of climate change on their availability in the future, is lacking. Thus, this research has been undertaken to develop, calibrate, and test a comprehensive process-based model in four mountainous watersheds of Colorado, and investigate the potential impacts of changing climate on hydrologic response in these basins. Specifically, the Soil and Water Assessment Tool (SWAT) was utilized to develop watershed-specific hydrology models with high-resolution spatial data for the Cache la Poudre, Gunnison, San Juan and Yampa River basins. All study basins exhibited a decreasing ratio of precipitation to potential evapotranspiration for emissions scenario ensemble averages, which suggests Colorado basins will become more arid over the 21st century. Implications of this study are considerable, as management of water resources, both within the state and across the West, will be affected by freshwater availability in headwater basins of Colorado in the future.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management

Outcome #9

1. Outcome Measures

Effects of Irrigated Agriculture and Riparian Vegetation on Fish Habitats

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)
: Dwindling water resources for rivers and agricultural production have challenged many farmers across Colorado to meet the water needs for crop production while also trying to conserve decreasing water supplies. The Arikaree River, on the eastern plains of Colorado, is fed by the High Plains Aquifer and provides both unique habitat for the endangered fish species and irrigation water for agricultural production. Research has shown that the aquifer has been declining at approximately 0.25 m/year throughout the region and in some locations, it is dropping at 0.58 m/year based on farmer observations.

What has been done
: A water conservation survey was distributed to farmers in Eastern Colorado (predominately in Yuma County) to identify the top three conservation alternatives in each section. The water conservation sections were field practices, irrigation practices, management practices, programs, and conversion to less water consumptive crops. The water conservation savings model was developed from a comprehensive literature review of agricultural water conservation alternatives. A numerical water balance model of the alluvial aquifer-stream system was developed to link groundwater to pool depths in the Arikaree River.

Results
Results show that irrigation pumping causes a decline in the water table elevation which can be linearly approximated at about 0.25 m/yr. Long-term modeling was performed using the equations determined from the water balance and Darcy's Law. The calculations show that the river is at a critical point for preservation and could go dry in the next 8 to 12 years with no changes to the current pumping. This research shows that to maintain the current HPA water levels and alluvial aquifer, it would require 77% participation in the water conservation programs or reduction of at least 44.8 million cubic meters of irrigation pumping.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management

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
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

· Weather conditions such as drought, flooding, hail, moisture/temperature trends influencing pathogen and pest life cycles, which will require short/medium/long term redirection of effort to accommodate program needs;
· Economic issues that may lead more individuals to acquire and/or redirect their IPM strategies according to resource limitations or opportunities;
· Continued funding through federal, state and county agencies;
· Changes by governmental and non-governmental agencies to irrigation and pest management requirements;
· Continued staffing of pest management Extension positions; and
· Continued increase in population of Colorado.

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

1. Evaluation Studies Planned

- Before-After (before and after program)
- Case Study
- Comparison between locales where the program operates and sites without program intervention

Evaluation Results

One measure of the impact of the Pest Management Work Team and BSPM IPM Program can be obtained by tracking changes in pest management practices and knowledge gained. For example, high correlation between changes in pesticide use and severity of pest problems would indicate practitioners have adopted sound pest management decision making. Periodic performance surveys of Extension agents, research scientists and BSPM IPM specialists are conducted to solicit input on effectiveness from statewide Extension faculty (via pre/post test instruments at meetings, clinics, field days),

other clientele and commodity groups. Additional feedback will be obtained from stakeholders and administrators on IPM and individual specialist performance. Behavior change surveys have been developed and implemented to determine impact six months and a year after participant exposure to extension workshops. These survey instruments utilize email addresses of the participants and the Internet product Survey Monkey.

Key Items of Evaluation

TheUS Census of Agriculture reports decreasing numbers of mid- and large-sized farms and a significant increase in the number of small farms. Small acreage owners/operators frequently may not possess much agricultural or business knowledge. AES and Extension address the needs of small acreage producers and work with agricultural industry personnel and governmental agencies to assure that land managers and communities can evaluate a broad range of opportunities to enhance viability while respecting the environment.