V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Climate Change: Natural Resources and Environment

☑ 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
101	Appraisal of Soil Resources			7%	
102	Soil, Plant, Water, Nutrient Relationships			10%	
111	Conservation and Efficient Use of Water			7%	
112	Watershed Protection and Management			11%	
121	Management of Range Resources			6%	
123	Management and Sustainability of Forest Resources			9%	
133	Pollution Prevention and Mitigation			18%	
136	Conservation of Biological Diversity			20%	
211	Insects, Mites, and Other Arthropods Affecting Plants			3%	
403	Waste Disposal, Recycling, and Reuse			7%	
405	Drainage and Irrigation Systems and Facilities			2%	
	Total			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	11.1	0.0
Actual Paid Professional	0.0	0.0	2.6	0.0
Actual Volunteer	0.0	0.0	2.3	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	621777	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	458554	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	28995	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The main goal of the Climate Change, Natural Resources and Environment research program continues to be to develop, perform and support scientific research regardig the impact of agricultural practices on the environment and natural resources of Puerto Rico. The program addresses key PRAEXS mission goals by supporting both the Department of Agriculture and the Natural Resources Department in the protection, utilization and management of soil, water, natural resources and quality of the environment through the improvement of agricultural practices. Past and ongoing research activities:

- Quantify the contribution of agriculture in relation to pollution source, and measure the short-and-long term impact of agricultural operations on the environment.
- Develop pollution prevention and mitigation (practice, measure, thresholds) for protection of watershed and soil resources.
- Develop soil improvement and maintenance practices.
- Develop and promote sustainable agricultural practices as a key component to foster agricultural-led economic growth in the island.
- Determine the factors that influence the sustainable agricultural production practices adoption in Puerto Rico.
- Determine the pathways of entry, ecological impact, and management of non-native species on biodiversity.
- Develop management approaches for conserving and restoring biodiversity.
- Publish research advancements in journals, bulletins, newspaper articles, and popular magazines.

In addition to publications, projects results have been disseminated through farm/field day visits, workshops, conferences, websites, podcasts, and exhibitions.

2. Brief description of the target audience

Extension specialists and agents, Faculty members and students, government partners, producers, consumers, and community-based groups.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	0	6	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Oral or poster presentations in professional scientific society meetings resulting from program activities

Year	Actual
2013	36

Output #2

Output Measure

- Number of Peer Reviewed publications.

Year	Actual
2013	6

Output #3

Output Measure

- Number of trainings, research demonstration activities and meetings with stakeholders to discuss research results and priorities.

Year	Actual
2013	17

Output #4

Output Measure

- Number of graduate students completing a MS degree and submitting theses under research projects in this program

Year	Actual
2013	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of stakeholders gaining knowledge on natural resources enhancement, dry forest ecology and management, microirrigation scheduling, and other soil enhancement and water conservation practices
2	Number of farmers adopting microirrigation management practices
3	Number of persons adopting practices that prevent biodiversity threats and losses.
4	Number of farmers adopting methods to increase soil organic matter content
5	Number of farmers reporting increased water use efficiency in their farms
6	Number of farmers that adopted practices to improve water resources.
7	Number of stakeholders gaining knowledge on organic agricultural practices.
8	Number of persons gaining knowledge effects of non-native species on biodiversity.

Outcome #1

1. Outcome Measures

Number of stakeholders gaining knowledge on natural resources enhancement, dry forest ecology and management, microirrigation scheduling, and other soil enhancement and water conservation practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	100000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Education is a first line of defense for the conservation and management of natural resources. PRAEXS access to stakeholders through traditional outreach methods is limited. Being the web an efficient and inexpensive tool to reach masses, in order to maximize outreach efforts several scientists of this research program have used this technology to reach a broader audience.

What has been done
The outreach of research activities has been varied and performed across disciplines in interdisciplinary groups. Several seminars, videos and symposiums have been celebrated. These activities have been documented through web videos, web seminars and podcasts. A special seminar series ?Coloquio AgroAmbiental? have been developed to discuss major issues regarding the natural resources and environment.

Results
The use of web sites, podcasts and blogs expands the exposure of our work to different audiences. The number of visitors to the Colloquium and selected projects? web pages are: Colloquium (6 videos, 52 hits; Recycling and manure 60,000+; sustainable agriculture 37,000+) other topics have registered 8,000; 17,000 and 62,000 hits.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources

Outcome #2

1. Outcome Measures

Number of farmers adopting microirrigation management practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	250

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farmers need of better micro-irrigation scheduling methods to reduce water, nitrogen and energy losses.

What has been done
Multidisciplinary studies have been performed in order to develop understanding and efficient technology to improve water conservation and management. Major outreach efforts have been carried out to increase micro-irrigation management and practices among the fruits, vegetables and root crops producers in the island.

Results
Micro-irrigation management and practices have been developed for crops such as avocado, pineapples and citrus located at northern and central regions of Puerto Rico, and root crops farmers at southern dry plains. Research results have been successfully disseminated through publications (2 peer reviewed papers and a book), field days, workshops and demonstrations. A web-based site provides vital information for irrigation needs in the different agricultural areas http://pragwater.com/daily-reference-eto-for-haiti-and the dominican -republic /web.page. The page was redesigned to estimate evapotranspiration coefficients for other Caribbean countries. These outreach efforts has provided vital knowledge for micro-irrigation management to farmers and growers in the island.

4. Associated Knowledge Areas

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

405 Drainage and Irrigation Systems and Facilities

Outcome #3

1. Outcome Measures

Number of persons adopting practices that prevent biodiversity threats and losses.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	300

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The impact of non-native species poses a serious challenge that requires a decision-making framework based in the prioritization of species for their control, as well as regulatory and public education programs. Public awareness and adoption of practices to prevent biological invasions are vital to this goal.

What has been done
Several multidisciplinary research studies have been performed in order to assess the impact of invasive species on agricultural and natural ecosystems. Different models, methods and practices for invasive management have been evaluated.

Results
Probabilities maps detailing suitability and survival of two invasive weeds were developed. A model of invasive species spread over time under alternative scenarios and control programs was developed. Public awareness of the invasive species problematic was improved through research outreach activities such as meetings, educational material and use of the Internet to reach a broader audience.

4. Associated Knowledge Areas

KA Code	Knowledge Area
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
136	Conservation of Biological Diversity

211 Insects, Mites, and Other Arthropods Affecting Plants

Outcome #4

1. Outcome Measures

Number of farmers adopting methods to increase soil organic matter content

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	100

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To increase the outreach efforts of substainable agricultural management and practices in order to promote their adoption by farmers and growers.

What has been done
Outreach efforts were incremented through different activities across disciplines and interest groups. Major efforts have been devoted to field days, meetings, seminars and workshops; several training and research demonstrations were also performed. Graduate students recruitment and mentoring was pursued in the program to ensure knowledge awareness and professional capacity development in the topic.

Results
Research results were presented in seminars, workshops and field demonstrations. More than seventy organic farmers, students, and general public were instructed about sustainable agricultural practices and organic soil amendments. Several videos were posted on the web site http://www.youtube.com/watch?v=bYhkbihjESA. Two graduate students completed their master degrees under associated projects.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation

403 Waste Disposal, Recycling, and Reuse

Outcome #5

1. Outcome Measures

Number of farmers reporting increased water use efficiency in their farms

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The southern region of Puerto Rico, the most active agricultural area in the island is characterized by its low rain fall. Drip irrigation is widely used in that region. However, farmers are not using irrigation scheduling methods, so years of ground water pumping are reducing the aquifers and causing salt water inclusion from the sea.

What has been done
A research project to evaluate Subsurface Drip Irrigation (SID) and cropping systems on vegetables was conducted in the southern region. Another ongoing project is a collaborative effort between the University of Alabama to create a remote sensing product for solar radiation for Puerto Rico, Haiti and Dominican Republic to estimate the evapotranspiration and the surface energy and water budgets.

Results
Research findings indicate the SDI contributes to a better water use efficiency for vegetables production in the semiarid region of southern Puerto Rico. Outreach activities have been performed to teach farmers the importance of using irrigation methods to increase water use efficiency on agricultural production. Judging from participants evaluations of outreach activities, project recommendations are likely to be adopted by approximately thirty participants. A commitee was organized to produce an Irrigation Manual designed for use of farmers, Cooperative Extension Agents and government agronomists.

4. Associated Knowledge Areas

KA Code	Knowledge Area

111	Conservation and Efficient Use of Water
405	Drainage and Irrigation Systems and Facilities

Outcome #6

1. Outcome Measures

Number of farmers that adopted practices to improve water resources.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
405	Drainage and Irrigation Systems and Facilities

Outcome #7

1. Outcome Measures

Number of stakeholders gaining knowledge on organic agricultural practices.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Organic stakeholders need more information on agricultural practices that improve soil quality in tropical soils. Information to achieve reductions in inorganic fertilization is needed by farmers in transition to organic production.

What has been done
A project to evaluate the effects of organic fertilization in soil quality and crop yield was established. The study gathered information on the development and use of compost in the tropics and its effect on organic matter build up, mineralization and crop yield. Another study evaluated the use and efficiency of the windrow composting technology for the composting of coffee residues.

Results
? Development of a high quality compost from coffee hulls and validation of the windrow composting technology
? Results and findings of this research were shared with the academic comunity (extensionists, researchers, students) and stakeholders at an AES open house, scientific meetings and a demonstrative greenhouse workshop.
? Ten educational videos and one conference regarding composting procedures, management and use were posted at Ytube and InfoCast respectively; more than 100,000 viewers have accessed both sites.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

Outcome #8

1. Outcome Measures

Number of persons gaining knowledge effects of non-native species on biodiversity.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The introduction of non-native species to both natural and agricultural ecosystems represents a serious threat to biodiversity, wildlife habitat, and agricultural production. A great number of extremely damaging agricultural pests have become established in Puerto Rico as a result of both accidental and intended introduction.

What has been done
Several research projects on biodiversity and conservation threats to agriculture and natural ecosystems have been established and are reporting progress in their work. The program coordinator has mentored a community group in the development of a bio-conservation project to restore the native fireflies habitat in the mountain region of the island.

Results
? Six predaceous coleoptera species have been identified in association with the Harrisia Cactus Mealybug.
? Four insect and one acari species have been introduced for the control of non-native aquatic weeds in the island?s watersheds. The introduction of these biocontrol agents have rendered between a 40-100% of control in the released areas.
? A new DNA extraction protocol was developed for palm and insect tissues.
? Research and Outreach activities have been performed to teach all targeted audiences how to prevent biodiversity threats and losses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

136	Conservation of Biological Diversity
211	Insects, Mites, and Other Arthropods Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Programmatic Challenges

Brief Explanation

Budget restrictions at the university continue to affect the performance of programs like this one, addressing multiple issues and with multi-disciplinary faculty.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Several outreach activities were performed to collect the program participants and stakeholder's inputs. Seminars and meetings are among the activities conducted. Methods used to collect information include surveys, personal interviews, end section questionnaires, and document review and analysis. Outreach activities have been documented through web videos, web seminars and podcasts. A special seminar series "Colloquio AgroAmbiental" have been developed to discuss major issues regarding the natural resources and environment. In addition, research results have been successfully disseminated through web sites, podcasts and blogs. Reaching these wide audiences has provided us with lots of inputs from concerned parties that came in the form of consultations, comments, and inquiries regarding services and major agricultural and environmental issues. Evaluation results will be used to improve the research program activities in order to enhance and achieve the stated goals and objectives according to the stakeholders needs.

Key Items of Evaluation

As a result of the gathered data several major issues have been identified some of them are common ground among the wide number of participants. Among the critical issues are; soil management and erosion control; need for guidelines for quality control and pollution prevention in watersheds; nutrients management; and providing a digitalized inventory of agricultural land for use in crop production and other land uses. Another major concern is the impact of non-native and/or invasive species in agricultural production systems and natural ecosystems. Finally, our audience shows a great interest in sustainable agricultural production in the context of food security. The capacity to comply with these research needs will depend on budget and human resources availability.