

V(A). Planned Program (Summary)

Program # 4

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
102	Soil, Plant, Water, Nutrient Relationships			16%	
111	Conservation and Efficient Use of Water			5%	
112	Watershed Protection and Management			13%	
122	Management and Control of Forest and Range Fires			6%	
123	Management and Sustainability of Forest Resources			6%	
133	Pollution Prevention and Mitigation			29%	
136	Conservation of Biological Diversity			7%	
216	Integrated Pest Management Systems			8%	
403	Waste Disposal, Recycling, and Reuse			3%	
404	Instrumentation and Control Systems			2%	
405	Drainage and Irrigation Systems and Facilities			5%	
	Total			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	0.0	0.0	10.0	0.0
Actual	0.0	0.0	11.4	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	699327	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	854488	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

During last year, the principal problems addressed by research under this program were associated with soil erosion, water quality, and protection and conservation of biodiversity. Research was conducted in order to develop soil management practices to minimize problems of poorly drained upland soils, including evaluation of micronutrient behavior in highly weathered soils, and of synthetic materials and ground cover germplasm for erosion control. Also conducted were studies to quantify off-field nutrient losses in runoff from tropical agroecosystems and factors influencing their transport.

In addition, research on the regeneration of native and introduced species in dry forest in response to multiple disturbances (fires, hurricanes, dominance by exotic trees) provided management tools to understand the role of these factors and tree response. Research to evaluate Subsurface Drip Irrigation (SDI) and cropping systems on vegetables continued to progress in the southern region of the island. As part of this activity, researchers collaborated with the University of Alabama to create a remote sensing product for solar radiation for Puerto Rico, Haiti and the Dominican Republic, valuable for estimating evapotranspiration and the surface energy and water budgets.

Various other research projects on biodiversity and conservation threats to agriculture and natural ecosystems reported significant accomplishments. Studies to determine life cycle duration and immature instar identification of *Harrisia Cactus Mealybug* (HCM) under laboratory conditions were completed. Morphological studies now allow the identification of HCM stage attacked by natural enemies. This pest is currently a threat to endangered and threatened cactus species endemic only to Puerto Rico. Other initiatives include the biocontrol of non-native aquatic weeds in watersheds using herbivore insects. The biological information obtained from these projects is likely to result in effective mitigation of the environmental and economic impact caused by the recent introduction of these invasive species into Puerto Rico. During 2010 the celebration of a weekly colloquium in which program participants shared the progress of their projects and salient research results with our targeted audiences, provided important feedback on the needs of program stakeholders and on how to improve the dissemination of results from our activities.

2. Brief description of the target audience

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

V(E). Planned Program (Outputs)

1. Standard output measures

2010	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	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	5	0	
Actual	0	7	7

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	Target	Actual
2010	15	12

Output #2

Output Measure

- Number of Peer Reviewed publications.

Year	Target	Actual
2010	5	7

Output #3

Output Measure

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

Year	Target	Actual
2010	10	6

Output #4

Output Measure

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

Year	Target	Actual
2010	2	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 persons that adopted practices to improve water resources.
7	Number of watersheds for which a Total Maximum Daily Load (TMDL) for nutrients have been developed

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	Quantitative Target	Actual
2010	100	300

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
136	Conservation of Biological Diversity

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	Quantitative Target	Actual
2010	30	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The southern region of Puerto Rico, the most active agricultural area on the island, is characterized by its low rainfall. Drip irrigation is widely used in that region. However, farmers are not using irrigation scheduling methods; therefore, years of ground water pumping are reducing the aquifers and causing salt water inclusion from the sea.

What has been done

As part of a continuing Hatch regional project Puerto Rico has conducted research and extension activities on microirrigation technologies and on the advantages of using an irrigation scheduling method to reduce water loss. Project participants have focused on different aspects of the problem, conducting research on remote sensing related to evapotranspiration, and on satisfying different crops water needs by using drip irrigation and fertigation. Publications, seminars, and field days have been conducted to disseminate results.

Results

Research findings indicate that Subsurface Drip Irrigation contributes to a better water use efficiency for vegetable production in the semiarid region of southern Puerto Rico. A committee was organized to produce an Irrigation Manual designed for use of by farmers, Cooperative Extension Agents, and government agronomists. Participants in dissemination activities showed willingness to adopt many of the suggested practices, but there has not been a study to document actual adoption.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

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	Quantitative Target	Actual
2010	50	100

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. Many non-native species with invasive traits may displace native flora, alter ecosystems processes, diminish crop yields, and harbor agricultural pests. Having suitable environmental conditions (e.g. tropical temperatures) and being a center of commerce and cargo mobilization of the Caribbean, Puerto Rico is constantly threatened by the introduction of nonnative species.

What has been done

Various research projects on biodiversity and conservation threats to agriculture and natural ecosystems have been conducted. Salient among these are studies to protect native and endangered cacti in dry forests from the invasive *Harrisia Cactus Mealybug* (HCM), research on the biocontrol of non-native aquatic weeds in watersheds using herbivore insects, and studies on the regeneration of native and introduced species in dry forests in response to multiple disturbances (fires, hurricanes, dominance by exotic trees). Program participants have also mentored community groups in the development of bioconservation projects.

Results

-To date six predaceous coleoptera species have been identified in association with the HCM. A peer reviewed paper with these findings has been submitted for publication. Two presentations have been prepared and offered to forest managers and to environmental groups to raise awareness of the HCM impact and mitigation strategies in the island's dry forest.

-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 has rendered between a 40 to 100% control in the released areas.

-A community group has established a bioconservation project to restore the native firefly habitat

in the mountain region of the island.

-Other 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
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
136	Conservation of Biological Diversity
216	Integrated Pest Management Systems

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	Quantitative Target	Actual
2010	20	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The majority of growers in Puerto Rico traditionally produce food crops using inorganic fertilizers and other high-cost external inputs. The use of these inputs raises production costs and could contribute to nutrient runoff or leaching, thus contribute to the contamination of water resources. Compost amendments on soils where vegetable crops are grown could have a great impact on soil quality and management practices.

What has been done

A project was established to evaluate the effects on crop yield of different organic matter amendments in four clay soils. The study gathered information on the development and use of compost in the tropics and its effect on organic matter buildup, mineralization and crop yield. This information is important to implement a transition to sustainable agriculture in Puerto Rico.

Results and findings have been shared with stakeholders in PRAES open houses and at a demonstrative greenhouse workshop.

Results

This project provided valuable information on organic agricultural practices. The study has shown that the use of mature compost improves soil quality properties and tomato crop yields in four tropical soils. This information is important for understanding the effect of organic matter on the improvement of soil quality (minimum chemical indicators and special chemical indicators). In addition, the use of coffee residues as compost has encouraged the recycling and use of a potential pollutant and its conversion into a valuable input. Most organic farmers attending outreach activities integrate compost into their operations, but conventional farmers also showed interest in the project's results.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
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	Quantitative Target	Actual
2010	20	30

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

Outcome #6

1. Outcome Measures

Number of persons that adopted practices to improve water resources.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Number of watersheds for which a Total Maximum Daily Load (TMDL) for nutrients have been developed

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	1	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Currently, all reservoirs in Puerto Rico are listed as impaired because of the violation of the dissolved oxygen (DO) aquatic criteria and flawed understanding of the mechanisms controlling DO dynamics in tropical reservoirs.

What has been done

Research was conducted to characterize the oxygen dynamics of two reservoirs of Puerto Rico listed as impaired waters for aquatic life. Results from this study generated the database and knowledge to elucidate the controversy and to determine the actual DO status of our water reservoirs.

Results

-The evidence gathered in this study sustains the study hypothesis that hypolimnion anoxia by itself does not constitute an adequate indicator of nutrient impairment in reservoirs of Puerto Rico.

- Collaboration between researchers of the PRAES and Department of Natural and Environmental Resources (DRNA) reservoir management personnel was established during the monitoring and sampling phase of this project.
- Government agencies have become aware of the impact of hypolimnion anoxia and its potential mitigation practices for water quality and fish habitat restoration. Results from this project are critical to guide the decision-making process.
- Research and outreach activities have been carried out to share knowledge about the findings of this project with personnel of Puerto Rico regulatory agencies (i.e. DRNA, Environmental Quality Board, and Aqueduct Authority).

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes
- Other (Budget cuts, lack of studies to document adoption)

Brief Explanation

Factors affecting our performance in 2010 showed little change from those portrayed in before. The prolonged economic recession affecting Puerto Rico and the strategies adopted by the government to handle it have resulted in falling appropriations for the state university and concomitant reductions in the local funds available for research. We also lack studies or survey results documenting adoption of recommended practices. Indicators provides are estimates gathered in outreach activities.

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

1. Evaluation Studies Planned

- Other (Undecided yet)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}