2010 University of Puerto Rico Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The University of Puerto Rico Agricultural Experiment Station (PRAES) mission within the College of Agricultural Sciences (CAS) is to conduct scientific research that promotes an economically viable agricultural sector, the conservation and enhancement of natural resources and the environment, and a better quality of life in rural and urban areas. Our research also supports the industries that process agricultural raw materials and provides the technological base required for solving the problems affecting farmers, public and private institutions, and for rural development. The PRAES coordinates its academic activities with the teaching and extension faculty of the CAS, and incorporates into its research program faculty of these other two institutional branches. Although for this Plan of Work (POW) cycle, the PRAES and the Puerto Rico Agricultural Extension Service have opted to continue with separate submissions, all of our planned programs include the collaboration of extension faculty in the activities proposed to disseminate results, and many also extend this collaboration to other key aspects of the research process.

The PRAES has administrative offices and carries out research activities at two main centers: Río Piedras, in the northern San Juan metropolitan area, and Mayagüez, on the west coast of the island, where the CAS Campus is located. In addition, the PRAES has six substations comprising more than 2,000 acres of land distributed in the different geographical and ecological zones of Puerto Rico. This wide distribution allows for the evaluation of crop and animal production systems adapted to the conditions of different ecological zones. In addition, to advance regional goals, the PRAES participates in both multistate research and Special Grants from USDA-NIFA that target agriculture in the Caribbean Basin of the United States.

Until 2006, research efforts in the PRAES were organized along traditional commodity lines. Commodity groups are still active and constitute an important link with our stakeholders, but they are no longer the basic unit structuring our research program. Adopting federal guidelines, in 2006 we began a transition towards defining and organizing research programs following the LOGIC model. Last year, following new NIFA's guidelines, all planned programs were reviewed and recontextualized to address both local goals and, when possible, the five national priorities of Global Food Security and Hunger, Climate Change, Sustainable Energy, Childhood Obesity and Food Safety. The names of our planned programs were slightly modified and hyphened to include the national priority addressed in its name. This change, however, is not reflected in this annual report, although the new outlook is present in some of the programs description of activities.

Core funding for the PRAES's research program is provided by various sources. State funds are primarily used to cover salaries of academic and support personnel. USDA funding is crucial for directly financing the research program and supplementing salaries of faculty and staff. Formula-funds include Hatch Regular, Hatch Regional, McIntire-Stennis and Animal Health, although we have not had an active Animal Health project since 2005. Special Grants such as the Tropical and Subtropical Agriculture Research (T-STAR Caribbean) support targeted areas of research important for Puerto Rico, Florida and the Virgin Islands. Along with federal and state funding, there are extramural research grants and contracts such as those with the Natural Resources Conservation Service, Environmental Protection Agency, USDA-ARS, Puerto Rico's Department of Agriculture, Puerto Rico's Department of Natural and

Environmental Resources and other agreements with US-Universities and private donors. For FY2010 the Hatch allocation for Puerto Rico was $4,151,062. Along with state matching funds and other program income the actual dollars spent in our planned programs in FY2010 was $7,842,204.

Planned Programs Overview

In 2010 the PRAES celebrated its 100th anniversary. Two-day open houses of all research centers and substations were held throughout the year, with field visits to experiments, conferences and workshops on the progress of our programs, distribution of publications, and historical exhibitions and accounts on the impact of a century of research in agriculture and natural resources. More than a celebration of past accomplishments, the centennial activities provided an opportunity to share with our stakeholders our vision on the continued relevance of PRAES programs to meet the new challenges posed by global economic forces and climate change in the quest to achieve greater local and global food security. This outlook is present in most programs' descriptions of 2010 activities and outcomes.

The **Milk and Meat Production Systems**program intends to improve the on-farm efficiency of the various livestock enterprises of Puerto Rico by means of identifying recommended management practices (RMP) and achieving their adoption on producers' farms. During 2010 the PRAES allocated 8.4 FTE/SY and more than a third of our Hatch funds to this program. Research continues to be directed toward alleviating the inordinate dependence of local animal production on imported concentrate feed. Results of research dedicated to the production of grass-fed cattle with or without supplementation, regarding animal growth, carcass characteristics, and quality of the resulting meat have been communicated locally and internationally, through presentations and publications. As the costs of nearly all necessary inputs for livestock production continue to increase, chances decrease for survival of inefficient operations. Given this scenario, research leading to more efficient procedures and innovative technology constitutes one of the most important driving forces for increased local livestock production. The educational campaign begun in 2008, which targets consumers on the nutritional value of locally-produced beef, still continues. The establishment of a quality grading system is expected to help organize the market, increase beef cattle prices, and build up consumer confidence and demand for the local product.

The small ruminant work group continued to be very active and their research on the use of novel high-quality forages as supplements to sheep or goats grazing on tropical grass pastures has given promising results. A survey revealed great variability in the sheep and goat meat offered for sale in local supermarkets and the need for better feeding and management practices and genetic selection of animals at the producing farms.

During 2010 collaborative research and surveillance efforts of our current crops and farming systems continued in our **Integrated Management of New and Emerging Pests and Diseases (IMNEP)** program. As a result of improved access to rapid diagnostic tests and surveillance, new important pests and diseases were identified in Puerto Rico. Asian soybean rust (ASR) caused by Phakopsora pachyrrhizi was identified in the northwest of the island in winter nurseries. The increase in the surveillance efforts of ASR was important for early detection and eradication of the infected plots. Progress was also made in promoting the use of reduced risk pesticides for several pests and diseases. In the case of Black Sigatoka, research results were important in the development of an integrated management program with reduced risk fungicides. For the coffee berry borer, alternative biocontrol practices using Beauveria bassiana were devised. Collaborations with the Agricultural Extension Service have continued in the design of research for alternative control practices for the recently identified diseases and pests, including "citrus greening", vectored by the citrus psyllid.

In spite of our efforts, most growers reported an increase in the incidence of diseases in vegetable crops and fruits caused by, in their opinion, the extended periods of rain in 2010. Predictions of disease outbreaks have been more difficult in unstable weather; plans are to continue with the surveillance of

exotic diseases to prevent their spread. During 2010 the PRAES dedicated 12.1 FTE/SY to address IMNEP program's goals.

The **Plant Genetic Resources, Breeding and Production Systems (PGRBPS)** program addresses the NIFA priorities dealing with Global Food Security and Hunger and Climate change. Puerto Rico is an island that is dependent on imported food for local consumption. The increase in the cost of imported food and feed grains during the past year has augmented the cost of living and threatens the economic viability of local production of meat, milk and eggs. The goal of many of the projects in the PGRBPS program is to reduce crop production costs, thus allowing local producers to be more competitive in a global market. During 2010, seed of improved varieties of sweet chili pepper, papaya, eggplant, bean, pigeonpea, field corn, sweet corn, black-eyed pea, tropical pumpkin, tropical-type sweet potato, tanier, banana, plantain, cassava, and taro were produced and sold at the PRAES substations. Fields at two substations were certified for organic production and organically-grown seed of several of these crops was also produced. The certified organic fields were also used to demonstrate to students and farmers appropriate techniques for organic production.

Some of last year's activities of potential benefit to Global Food Security and Climate Change include the release of high-yielding tropical-type sweet potato "Pujols"; the recommended release of tropically-adapted sweet corn O.P. population "Suresweet 11", which has less ear damage caused by insects under an organic production system; and the identification of bean breeding lines more efficient in the acquisition of nitrogen. Hundreds of copies of technological packages and bulletins describing best management practices for local crops were distributed during 2010, particularly during the PRAES 100th anniversary open-houses of research centers and substations. The PGRBPS program engaged during last year 16.1 FTE/SY and received approximately twenty percent of our Hatch funds.

The main goal of the **Natural Resources and Environment** program has been to develop, perform and support scientific research on the impact of agricultural practices in the environment and natural resources. During last year, the principal problems addressed by research under this program were associated with soil erosion, water quality and conservation, and protection and conservation of biodiversity.

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. 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 by farmers, Cooperative Extension Agents, and government agronomists**.**

Several research projects on biodiversity and conservation threats to agriculture also 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.

In the area of water quality, research on the oxygen dynamics of two reservoirs of Puerto Rico listed as impaired waters for aquatic life was completed. 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. Results from this Hatch study generated the database and knowledge to elucidate the controversy, and to determine the actual DO status of our water reservoirs. Government agencies have become aware of the impact of hypoliminion 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.

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. The PRAES allocated 11.4 FTE/SY to this program. More than half of the projects were sponsored by non-formula funds but Hatch funds were vital to leverage external funds.

The **Agricultural Economics, Marketing, Value Added and Community Development (AEMCD)** program and the **Food Safety, Science and Technology (FSST)** program continue to be the smallest in our research portfolio in terms of FTE and formula funds allocation. They are, however, vital to guide our strategic efforts and priorities and to deliver value added technologies for Puerto Rico's principal crops that could enable agriculture to become a more economically attractive alternative. During 2010, AEMCD researchers conducted several surveys: a survey of consumer preferences for plantains and related produce, a survey of meat stand owners in local markets, and a survey of ornamental companies to estimate unit costs of producing ornamental products. Results of these activities were presented to producers and agricultural professionals particularly during workshops and seminars offered as part of the 100th anniversary celebration of the PRAES. The total FTE/SY dedicated to this program in 2010 was 1.4.

The **Food Safety, Science and Technology (FSST)** participants continued last year with their planned research and outreach activities as programmed. Researchers working on the design of more efficient methods to dry parchment coffee and high quality coffee cordials constructed a laboratory-scaled dehydration unit that allows for the study of relative humidity of air in the dehydration patterns of parchment coffee. Projects working on the development of new products based on local crops, such as the development of a fermented bread from cassava flour and a nutritional cream-cereal from pigeon peas, are already on a stage in which products are being evaluated on standard parameters and by sensory analysis.

At the same time, outreach activities geared to the local food industry have continued. More than 20 workshops have been offered on different aspects of food safety, tailored to the needs of different types of audiences: producers in the farm, processors and government officials. Several additional service contracts with local food industries were also established during the year. Program participants have also continued their search for external resources and have succeeded in some of the grant competitions. The total FTE devoted to this program in 2010 was 2.7.

Finally, as was stated by several program coordinators collaborating in this report, research and outreach activities were conducted in 2010 against a backdrop of a general economic recession in the USA and Puerto Rico, a very tight budget situation of our institution, and a decidedly abnormal year because of student unrest and prolonged strikes. A university-wide freeze of faculty positions and new appointments continue to hamper our efforts to expand research and outreach activities, and to evaluate the impact of our programs. Administrative measures, nevertheless, are continuously been taken to adjust our program priorities and expectations to changing conditions, and to guarantee that within available resources, our mission and goals are met and advanced.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2010	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	57.3	0.0
Actual	0.0	0.0	52.1	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- Internal University Panel
- Expert Peer Review

2. Brief Explanation

There has been no significant change in our Program Review Process since our last year update was submitted. In 2005, however, we changed the way in which our Hatch-funded research proposals are initially granted. In response to internal and external evaluations requesting that a portion of Hatch funds be allocated to projects on the basis of an annual call for proposals with the year's revised priorities, part of our formula-funded research is now competitively granted within CAS on the basis of said proposals. More specifically, the scientific peer review process of Hatch proposals is the following:

An annual call for proposals which includes the year's revised research priorities is prepared and distributed by the PRAES Research Office. Proposals are submitted to the Assistant Dean for Research with the preliminary endorsement of the respective Department Head. The Assistant Dean for Research sends the proposal again to the corresponding department head, to a local peer reviewer and to an external reviewer for their written comments on the scientific merit of the proposed research and compliance with the AES strategic plan. Proposals and their reviewers' input are discussed and evaluated by the CAS Associate and Assistant Deans for Research, and a final decision is taken by the administration. Project directors of the selected proposals are given the opportunity to incorporate reviewers' suggestions and make adjustments as appropriate. These proposals are then sent to the USDA-NIFA Office of the Administrator, where the respective national program leaders review them. Once the proposals are approved in Washington, the new or revised projects are included in the PRAES research program.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals

Brief explanation.

Two types of meetings are held in Puerto Rico to identify critical issues that should be addressed by AES research programs. Stakeholder input is also considered during the establishment of research priorities. First, the AES will continue to celebrate an annual meeting with researchers, extension faculty, farmers and other members of the public interested in the work performed by the different programs or commodity groups. In these meetings the progress of active research projects is discussed, preliminary results are shared and further input is sought from participants to update research needs and priorities. The meeting is usually celebrated in the Research Center or Substation closest to the principal area of production, and coordinated with the Agricultural Extension Service commodity specialist and agricultural agents of the region. Both the commodity leader and the extension personnel identify and invite members of producers associations, individual farmers, faculty and students, government officials, and community

organizations with an interest in the commodity's work and related research programs. The input received in these meetings from all the stakeholders present is summarized, evaluated and presented in a meeting of commodity group leaders, program coordinators and research administrators, where final decisions are made concerning research priorities. The list of priorities assembled through this process guides the year's call for proposals for new Hatch and Special projects.

Second, commodity group leaders, program coordinators and directors of integrated academic departments will continue to organize thematic workshops, seminars, and field days where research results will be shared and the research and extension needs, or public policy determinations, will be discussed.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Other (consultations with local extension agents and commodity leaders)

Brief explanation.

Stakeholders are identified through commodity leaders, extension personnel and through local advisory committees established by administrators of the CAS.

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder individuals

Brief explanation.

Input from stakeholders is collected at the meetings conducted by commodity and program leaders. Stakeholders are asked about the most critical issues affecting their commodities and localities and about our research priorities. This information is summarized in a report made by the commodity and program leaders.

3. A statement of how the input will be considered

- To Identify Emerging Issues
- Redirect Research Programs
- In the Staff Hiring Process
- To Set Priorities

Brief explanation.

Stakeholders input have been used in the determination of the research priorities of each planned program and commodity group, and these in turn, have guided the Request for Proposals released by the PRAES Research Office during the year. The inputs received during the past three years from traditional and non-traditional stakeholders and from government officials, have been critical for starting a pilot organic experimental farm, and for guiding our research infrastructure

development to better deal with the threats presented by invasive species.

Brief Explanation of what you learned from your Stakeholders

- The list of problems identified by our stakeholders as plaguing their operations is very long, but on closer analysis reveals that in many instances there are already technological alternatives available that have been researched and could improve their situation, if they could be more actively disseminated among Extension personnel and farmers. This closer integration between research and extension needs to be coordinated at higher administrative levels. Last year, steps were taken by administrators in this direction, and a closer collaborative relationship is being established between research and extension faculty working in our Integrated Management of New and Emerging Pests program and Extension's Crop Protection program. Already this collaboration has been instrumental for quickly assembling an integrated research and extension team to prepare an emergency response to the recently detected citrus greening disease.

-Participants in stakeholders' meetings would like to see a stronger participation in these activities from all components of the agrofood system: farmers, processors, distributors and government officials in charge of the agricultural sector. Many farmers expressed their willingness to partner in research projects and were supportive of on farm collaborations.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	4151062	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	3669701	0
Actual Matching	0	0	3872975	0
Actual All Other	0	0	299528	0
Total Actual Expended	0	0	7842204	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	0	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Milk and Meat Production Systems Resources
2	Integrated Management of New and Emerging Pests
3	Plant genetic resources, breeding and production systems
4	Natural Resources and Environment
5	Agricultural Economics, Marketing, Value Added and Community Development
6	Food Safety, Science and Technology

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Milk and Meat Production Systems Resources

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
202	Plant Genetic Resources			5%	
205	Plant Management Systems			15%	
301	Reproductive Performance of Animals			10%	
302	Nutrient Utilization in Animals			15%	
303	Genetic Improvement of Animals			10%	
304	Animal Genome			5%	
306	Environmental Stress in Animals			15%	
307	Animal Management Systems			10%	
308	Improved Animal Products (Before Harvest)			10%	
313	Internal Parasites in Animals			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	11.0	0.0
Actual	0.0	0.0	8.4	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	1561765	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1178961	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	299528	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The research topics most actively pursued during the year, as listed below, were mostly a continuation of ongoing endeavors, but with some additions and deletions:

(1) Feeding and management protocols for producing grass-fed beef of high quality at an appropriate age of slaughter.

(2) Identification of, and use of, genetic markers to assist selection of cattle, with emphasis on the Senepol breed and its crosses.

(3) Compositional and organoleptic evaluation of locally produced beef and its comparison to the imported product.

(4) Economic studies applicable to beef cattle in Puerto Rico of breeding (cow-calf) operations and growing-finishing operations, prepared in conjunction with a UCAR (Unit of quality and high yield) project that was approved by the Commonwealth Department of Agriculture.

(5) Female reproductive physiology in swine.

(6) Agronomic and nutritional characterization of numerous types of forages including improved grasses, tropical legumes and non-legume shrubs.

(7) Ensiling and hay-making procedures using different forages with or without the aid of chemical or microbiological additives.

(8) Weed control in forage crops, and control of invasive vegetative species by grazing goats.

(9) Use of banks of high-tannin forages to combat internal parasites and of legumes in protein banks to supplement small ruminant rations.

(10) Detection of resistance to anthelmintics for control of internal parasites in dairy heifers

(11) Glycerol feeding to lactating dairy cows.

(12) Effect of exercise on body thermoregulation in pregnant and non-pregnant dairy cows.

The outreach activities performed under this Program Area by the four de facto work groups concerned with (1) beef cattle, (2) small ruminants and forages, (3) dairy cattle, and (4) swine included 24 lectures or seminars, 8 training sessions, 6 field days, and numerous technical consultations with producers (individually and in groups) and with government officials, in addition to other extensionist endeavors, especially in the case of beef cattle and swine. Outreach activities were conducted in 2010 against a backdrop of a general economic recession in the USA and Puerto Rico, a very tight budget situation of our institution, and a decidedly abnormal year because of student unrest and prolonged strikes, in addition to the loss of two specialists from the Agricultural Extension Service. The level of stakeholder participation in the outreach activities was variable but sufficient to inspire cautious optimism.

2. Brief description of the target audience

Dairy farmers, beef cattle producers, producers of sheep and goats, swine, and commercial hay and haylage; extension personnel, government representatives, scientists, students, and private professionals.

V(E). Planned Program (Outputs)

1. Standard output measures

2010	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: 2010

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Actual	0	9	9

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of meetings held with stakeholders to discuss the industries' situation and research priorities

Year	Actual
2010	6

Output #2

Output Measure

- Number of popular (non-refereed) publications prepared based on research results.

Year	Actual
2010	6

Output #3

Output Measure

- Number of field days held in research facilities and/or private farms to demonstrate RMPs based on research results.

Year	Actual
2010	6

Output #4

Output Measure

- Number of publications made in refereed scientific journals.

Year	Actual
2010	9

Output #5

Output Measure

- Number of participants in the field days coordinated with Extension

Year	Actual
2010	150

Output #6

Output Measure

- Number of presentations of research results at meetings of scientific societies

Year	Actual
2010	16

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of participants in field days willing to adopt the RMPs demonstrated.
2	% market participation of local beef.

Outcome #1

1. Outcome Measures

Number of participants in field days willing to adopt the RMPs demonstrated.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	32	39

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The guiding principle of our outreach activities is to familiarize livestock and commercial forage producers with RMP and encourage their implementation at the farm level. Since 2009 we have been preparing a growing list of RMP submitted by members of the four work groups under this Program Area, and these RMP are emphasized as topics to be included in outreach activities.

What has been done
Research and extension results have been communicated to local stakeholders in different types of publications. Numerous outreach activities took place during the year including seminars, training sessions, field days, and technical consultations with producers and with government officials.

Results
Although we still do not have a reliable measure of RMP adoption in all work groups, we can cite as an example of successful attempts in this regard the acceptance by a majority of exposed milk producers of the use of Dairy Herd Improvement Program records to evaluate (1) milk production efficiency, (2) udder health management, and (3) reproductive status of the herd. If these producers follow through with consistent application of the RMP in question they will, in all probability, receive economic benefit.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
301	Reproductive Performance of Animals

302	Nutrient Utilization in Animals
306	Environmental Stress in Animals
307	Animal Management Systems

Outcome #2

1. Outcome Measures

% market participation of local beef.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Retirement of faculty collaborating in program)

Brief Explanation

For many months we did not make hay because of the lack of an operational bailing machine. Funds were not available to purchase as much hay as would have been desirable.

As for human resources, ten years ago there were three full-time Extension Specialists devoted to the dairy industry, now we have only one part-time faculty in this capacity after the retirement last year of our Extension Dairyman. This situation creates a big void in our means of contact with stakeholders of the dairy industry. Due to the tight budget situation there is still in force a university-wide freeze on new appointments.

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

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Integrated Management of New and Emerging Pests

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
211	Insects, Mites, and Other Arthropods Affecting Plants			16%	
212	Pathogens and Nematodes Affecting Plants			23%	
213	Weeds Affecting Plants			2%	
215	Biological Control of Pests Affecting Plants			32%	
216	Integrated Pest Management Systems			27%	
	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	14.1	0.0
Actual	0.0	0.0	12.1	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	445208	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	396825	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

As a result of improved access to rapid diagnostic tests and surveillance, new important pests and diseases were identified in Puerto Rico. Asian soybean rust (ASR) caused by Phakopsora pachyrrhizi was identified in the northwest of the island in winter nurseries. The increase in the efforts in the surveillance of ASR has been important for early detection and eradication of the infected plots. Lobate lac scale, Paratachardina pseudolobata, a scale that affects more than 150 species of woody plants, was reported in Garcinia intermedia. Another important scale identified was Pine Tortoise Scale, Toumeyella parvicornis, identified in Pinus. In the southwest of the island, increased precipitation during the summer months of 2010 resulted in the death of papaya tree plantations; waterlogged areas caused severe decline of trees because of Phytophtora palmivora. Understanding the climate factors influencing these outbreaks will help in the identification of sustainable agricultural practices and will prevent spread of the diseases to major production areas.

Progress has also been made in promoting the use of reduced risk pesticides for several pests and diseases. After evaluating systemic and contact fungicides, the PRAES designed a Strategic Management Plan for Black Sigatoka. The new IPM program for Black Sigatoka (BS) in banana was disseminated in two field days held in collaboration with the Extension Service. Removal of affected banana leaves and use of reduced risk fungicides is being implemented by growers for BS control in the north central production areas. Activities for the resistance management program against Lepidopterous pests in horticultural crops in Puerto Rico focused on natural enemies conservation and pesticide selection principles to lessen the economic impact of the tomato fruit worm (TFW) Helicoverpa zea. Results from the validation of IPM practices for TFW, in peppers and tomatoes, indicated that egg parasitoids are efficient at lower TFW densities. Also demonstrated has been the lack of effectiveness of pesticides under TFW outbreaks. Collaborations with the Extension Service have continued in the design of research for alternative control practices for the recently identified diseases and pests, including "citrus greening", vectored by the citrus psyllid.

2. Brief description of the target audience

- •Extension Specialists and Agents;
- •Academic Programs Faculty and Students;
- •Producers and Commodity Groups;
- •Consumers; and
- •Federal and State Agricultural Agencies (PRDA, USDA/APHIS, USDA/ARS, USDA/NRCS).

V(E). Planned Program (Outputs)

1. Standard output measures

2010	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: 2010

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Actual	3	10	13

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of 'Pest Management Strategic Plans' (PMSPs) developed

Year	Actual
2010	1

Output #2

Output Measure

- Number of peer-reviewed articles in major scientific journals resulting from program activities.

Year	Actual
2010	5

Output #3

Output Measure

- Peer reviewed articles in local Scientific Journals resulting from program activities.

Year	Actual
2010	8

Output #4

Output Measure

- Abstracts or oral presentations in professional scientific society meetings resulting from program activities.

Year	Actual
2010	15

Output #5

Output Measure

- Poster presentations in professional scientific society meetings resulting from program activities

Year	Actual
2010	20

Output #6

Output Measure

- Number of joint Research-Extension activities that include pest diagnostics and identification, use of reduced impact pesticides, or research on pesticide impact assessment on non-target beneficial organisms.

Year	Actual
2010	6

Output #7

Output Measure

- Number of program-sponsored scientific events, like symposia, topic conferences, and open houses

Year	Actual
2010	6

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of stakeholders with increased knowledge on emerging pests and aware of non-target pesticide effects (Short Term)
2	Number of persons who adopted reduced risk pesticides and practices
3	Number of farmers reporting decreased losses due to key and emerging pests

Outcome #1

1. Outcome Measures

Number of stakeholders with increased knowledge on emerging pests and aware of non-target pesticide effects (Short Term)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	150	160

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Collaborative efforts between research and extension have continued regarding the development and dissemination of alternative practices for managing production constraints associated with emerging pests and diseases of major crops in Puerto Rico.

What has been done
Workshops and field demonstrations on citrus greening were organized for citrus growers, Extension agents and agronomists. The AES faculty prepared training sessions and educational materials on management practices for controlling the disease. Also, dissemination was done regarding the timely use of reduced risk pesticides against Black Sigatoka (BS) and the coffee berry borer (CBB). The Plant Disease Clinic (PDC) worked closely with seed companies in the detection of diseases for quarantine pathogens in several crops. Two workshops directed to 32 inspectors were conducted in 2010.

Results
In the citrus greening workshops more than eighty citrus growers, Extension Specialists and Agronomists were oriented in the importance of psyllid control and disease prevention. For CBB the use of Beauveria bassiana was emphasized, and growers have adopted the use of this biocontrol with relative success in several of the major coffee producing the areas. In the PDC more than 4,500 determinations were conducted in the samples submitted. Sixty percent of the samples were part of the certification process for the Seed Industry established in the island.

4. Associated Knowledge Areas

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

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

Outcome #2

1. Outcome Measures

Number of persons who adopted reduced risk pesticides and practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	25	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Progress has been made in promoting the use of reduced risk pesticides for several pests and diseases. The strategies devised, along with cultural practices, will be fundamental to sustain banana, plantain, and coffee production in the island.

What has been done
In Black Sigatoka, research results were important in the development of an integrated management program with reduced risk fungicides. For the coffee berry borer (CBB), alternative biocontrol practices using Beauveria bassiana were devised. Seminars were presented to farmers, agronomists and field inspectors.

Results
The study performed with the CBB indicated that Beauveria bassiana can effectively produce mortality of 60 percent of CBB adults attacking young berries. In the case of BS an intensive campaign promoting the use of the alternative control practices devised is being carried out by both extensionists and researchers. We still lack, however, precise numbers on farmers' adoption of the new technologies and practices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants

216 Integrated Pest Management Systems

Outcome #3

1. Outcome Measures

Number of farmers reporting decreased losses due to key and emerging pests

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	25	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
More than five hundred stakeholders visited the Plant Disease Clinic (PDC) at Juana Diaz in 2010. Growers who visited the PDC were in general more knowledgeable of pest and diseases in crops than those who visited in previous years. Their abilities to recognize the importance of pest and disease diagnosis has been influenced by the Clinic's effort to engage the growers in the disease identification process. However, increased incidence and severity of bacterial diseases in corn and vegetables has been found after sample analysis in several crops.

What has been done
Over 4,500 determinations were conducted at the PDC and new findings of important pests and diseases were reported. Lobate lac scale, Paratachardina pseudolobata, was reported in Garcinia intermedia. Another important scale identified was Pine Tortoise Scale, Toumeyella parvicornis, identified in Pinus. The increased efforts in the surveillance of Asian soybean rust resulted in the identification of Phakopsora pachyrrhizi in winter nurseries. These findings were crucial in the early detection and eradication of the infected plots.

Results
In spite of our efforts, most growers reported an increase in the incidence of diseases in vegetable crops and fruits due, in their opinion, to extended periods of rain and low temperatures during 2010. New research priorities will address the management and prevention of Phytophthora palmivora in papaya as a result of the severity of last year's infestation with Phytophthora fruit and root rot. Predictions of disease outbreaks have been more difficult in unstable weather; plans are to continue with the surveillance of exotic diseases to prevent their spread.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Other (Lack of resources to assess progress in technology adoption)

Brief Explanation

Most growers suggested that the extensive periods of rain experienced last year increased the incidence of diseases in fruits and vegetable crops. In the recent past, however, the situation had been the opposite, with severe droughts affecting the major agricultural production region. The incorporation of better modeling tools related to climate change may help to sharpen predictions of disease outbreaks in the future. In addition, budget cuts and the university-wide freeze on new appointments continue to hamper our efforts to expand research and outreach activities, and to evaluate the impact of our programs.

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

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Plant genetic resources, breeding and 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			20%	
202	Plant Genetic Resources			20%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			25%	
204	Plant Product Quality and Utility (Preharvest)			5%	
205	Plant Management Systems			30%	
	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	18.5	0.0
Actual	0.0	0.0	16.1	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	834995	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1329747	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

The lack of availability of seed of traditional crops has been identified as a major factor limiting crop production in Puerto Rico. During 2010, seed of improved varieties of sweet chili pepper, papaya, eggplant, bean, pigeonpea, field corn, sweet corn, black-eyed pea, tropical pumpkin, tropical-type sweet potato, tanier, banana, plantain, cassava, and taro were produced and sold at the PR Agricultural Experiment Station (PRAES) substations. Farmers who purchase the seed provide the plant breeders with valuable feedback concerning the strengths and weaknesses of the cultivars. In most cases, demand for seed exceeds supply.

During the past year, fields at two substations were certified for organic production. This certification permitted the initiation of the production of organically-grown seed of sweet chili pepper, tropical pumpkin, cucumber, black-eyed pea, and tropical-type sweet potato. The certified organic fields have also been used to demonstrate to students and farmers appropriate techniques for organic production.

During the next few decades, significant increases in food production will have to come from tropical cropping systems. Some of the 2010 activities of this program of potential benefit to Global Food Security and Climate Change are listed below:

1. The high-yielding tropical-type sweet potato 'Pujols' was formally released by the PRAES.
2. Results of studies on the variability in sugars among tropical-type sweet potato varieties were published.
3. The tropically-adapted sweet corn O.P. population 'Suresweet 11' has been recommended for release by the PRAES. 'Suresweet 11' has less ear damage caused by insects under an organic production system.
4. Bean breeding lines more efficient in the acquisition of nitrogen were identified.
5. The post-harvest root deterioration of 25 cassava roots was evaluated visually and by using hydrocoumarins florescent accumulation analysis.
6. PRAES projects selected crops for adaptation to warmer and/or drier climates. Management practices to improve the efficiency of use of water were also studied.
7. The PRAES participated in the release of the heat tolerant bean germplasm lines TARS HT-1 and TARS HT-2.

The PRAES also makes a significant contribution to U.S. public rice and common bean breeding programs by conducting winter nurseries at two substations. Conducting these winter nurseries provides an opportunity for PRAES scientists to maintain expertise producing these staple crops under local conditions.

We continued to experience notable progress in hosting activities for stakeholders at the stations facilities and in other experimental fields. Attendees to field days and associated activities totaled more than 300 stakeholders. Plantings at the substations are often used for formal and informal training activities to demonstrate BMPs. Also, several web sites related to the Plant Genetic Resources, Breeding and Production Systems program were developed last year, or had additional content added to existing sites. Noteworthy progress was made attracting external funds for activities related to this program. During 2010, program scientists obtained 13 grants from seven competitively funded requests for proposals.

2. Brief description of the target audience

Targeted audience consists of farmers, government professionals, legislators, county agents, scientists, USDA professionals, professionals from the private sector, and nonprofit organizations.

V(E). Planned Program (Outputs)

1. Standard output measures

2010	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: 2010
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Actual	0	26	26

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of stakeholders to adopt the proposed BMPs.

Year	Actual
2010	120

Output #2

Output Measure

- Focus groups of collaborators' opinions of the new technologies being validated

Year	Actual
2010	0

Output #3

Output Measure

- The number of 'hits' on project-related web sites Records of the sale of hard copies of AES publications.

Year	Actual
2010	2000

Output #4

Output Measure

- Records of the number and type of germplasm accessions distributed to scientists and the public.

Year	Actual
2010	250

Output #5

Output Measure

- Number of participants in the field days coordinated with Extension

Year	Actual
2010	333

Output #6

Output Measure

- Number of students attending field days to seed production fields, germplasm collections and other experimental fields.

Year	Actual
2010	125

Output #7

Output Measure

- Number of refereed publications

Year	Actual
2010	26

Output #8

Output Measure

- Number of non-refereed publications

Year	Actual
2010	21

Output #9

Output Measure

- Number of presentations in scientific meetings

Year	Actual
2010	40

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of stakeholders to adopt the proposed BMPs
2	Records of the sales of seed of improved cultivars at the Substations.

Outcome #1

1. Outcome Measures

Number of stakeholders to adopt the proposed BMPs

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	120	120

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farmers in Puerto Rico need to increase yield and reduce production costs in order to be able to compete in a global economy. In addition to greater efficiency and profitability, more sustainable agricultural practices need to be developed to take advantage of natural services and to minimize negative impact on the environment. Much of the research of the PRAES Plant Genetic Resources, Breeding and Production System program is directed toward the development of Best Management Practices (BMPs) that are published in collaboration with the Extension Service in technology packages for crops of economic importance in Puerto Rico.

What has been done
Printed copies of technology packages for different crops are distributed to farmers. Electronic versions are also available on the internet. BMPs are also discussed at field days and workshops sponsored by the PRAES and the Extension Service. Improved cultivars are an important component of BMPs. The PRAES has developed and released improved cultivars of several traditional crops. Seed of these improved cultivars are produced by the PRAES; however, the demand for seed often exceeds supply.

Results
The PRAES seed program offers for sale seeds and seedlings of improved cultivars that are adapted to local conditions. PRAES provides vital support for the continued production of traditional crops because seed is not usually available from the private sector in Puerto Rico. Hundreds of copies of technological packages and bulletins describing BMPs for local crops were distributed during the past year, particularly during the PRAES 100th anniversary open-houses of research centers and substations. The number of stakeholders, especially farmers, attending activities sponsored by the PRAES has continued to increase, which suggests an increased willingness of producers to adopt BMPs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

Outcome #2

1. Outcome Measures

Records of the sales of seed of improved cultivars at the Substations.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	115	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farmers frequently comment that a lack of high quality seed and propagation material limits the acreage and production of traditional crops. Farmers in Puerto Rico are typically smallholders, and commercial seed companies often do not maintain an inventory of the seeds or propagation materials used by these producers.

What has been done
The PRAES seed program offered for sale seeds and sets of varieties adapted to local conditions and management systems. The PRAES is the only reliable source of seed for many traditional crops.

Results
The sale of seeds and seedlings of improved cultivars remained strong during 2010. We believe this is an indicator of farmer support and adoption of improved cultivars developed by the PRAES plant breeding programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area

202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Competing Programmatic Challenges
- Other (Lack of precise evaluation mechanisms)

Brief Explanation

Factors affecting our performance in 2010 showed little change from those portrayed 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. The price of fertilizers and other inputs also remained relatively high, directly affecting the profitability of crop production and farmers capacity to incorporate more of the recommended practices into their operations. As is the case with most of our planned programs, some of our original measures were underestimated, whereas others were overestimated. Given that a concerted effort was made this year to portray the impacts of our programs during the PRAES 100th anniversary celebrations, we estimate that the number of stakeholders who increased their knowledge and adopted our recommendations have increased. However, we still lack a more reliable mechanism to asses the impact of program-based research.

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

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

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
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2010

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
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	Actual
2010	12

Output #2

Output Measure

- Number of Peer Reviewed publications.

Year	Actual
2010	7

Output #3

Output Measure

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

Year	Actual
2010	6

Output #4

Output Measure

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

Year	Actual
2010	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 finding 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 hypoliminion 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 hypoliminion 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)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Agricultural Economics, Marketing, Value Added and Community Development

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
601	Economics of Agricultural Production and Farm Management			30%	
604	Marketing and Distribution Practices			30%	
606	International Trade and Development			10%	
607	Consumer Economics			20%	
608	Community Resource Planning and Development			5%	
610	Domestic Policy Analysis			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	2.0	0.0
Actual	0.0	0.0	1.4	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	70678	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	69376	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

A consumer survey was performed to determine consumer preferences for plantains and related produce. The increase in the price of plantain was found to be an important determinant of lower plantain demand. Size and greenness of the fruit were deemed important determinants of quality as perceived by consumers. Local produce was deemed fresh and of higher quality. A survey of meat stand owners in local markets was conducted. Preferences for different kinds of meats were ascertained. Local meats were perceived as having higher nutritional content and greater overall quality, as well as being fresher. In general there was a greater willingness to pay for local meat and plantain. A survey of ornamental companies was also undertaken to estimate unit costs of producing ornamental products. The input-output matrix for Puerto Rico was obtained to compute the impact of the ornamental sector on the economy of Puerto Rico. Interviews and meetings were held with land grant stakeholders to identify public policy issues that are of concern to them. Methodological issues were discussed as to the best ways to produce public policy education materials relevant to local audiences, and as to how to convert the outcome of research into educational products. A forum on organic agriculture was held, and information on research and education needs of the audience was collected and analyzed. Finally, important and seldom available secondary data on agricultural commodities were collected, analyzed and published for use by the general public and the scientific community. Results were presented to producers and agricultural professionals particularly during workshops and seminars offered as part of the 100th anniversary celebration of the PRAES.

2. Brief description of the target audience

Farmers, extension professionals, community leaders and organizers, producers associations and other professionals.

V(E). Planned Program (Outputs)

1. Standard output measures

2010	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: 2010

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Actual	0	1	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of refereed publications

Year	Actual
2010	1

Output #2

Output Measure

- Number of presentations in scientific meetings

Year	Actual
2010	2

Output #3

Output Measure

- Number of non-refereed publications (posters, newspaper articles, etc.)

Year	Actual
2010	5

Output #4

Output Measure

- Number of participants attending workshops coordinated with Extension on program's results

Year	Actual
2010	112

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of stakeholders gaining knowledge about new markets and marketing tools (medium term measure)

Outcome #1

1. Outcome Measures

Number of stakeholders gaining knowledge about new markets and marketing tools (medium term measure)

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	350	620

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices
607	Consumer Economics
608	Community Resource Planning and Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Other (Limited number of faculty conducting research and extension in this program)

Brief Explanation

The prolonged economic crisis of the island,budget cuts at the university, and the

university-wide freezing of faculty positions continue to hamper our efforts to expand research and outreach activities, and to evaluate the impact of our programs

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

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Food Safety, Science and Technology

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
501	New and Improved Food Processing Technologies			33%	
502	New and Improved Food Products			37%	
503	Quality Maintenance in Storing and Marketing Food Products			5%	
504	Home and Commercial Food Service			10%	
701	Nutrient Composition of Food			15%	
	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	1.7	0.0
Actual	0.0	0.0	2.7	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	57728	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	43578	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 2010 Food Safety, Science, and Technology (FSST) participants continued with research and outreach activities as programmed. Researchers working on the design of more efficient methods to dry pergamino coffee and high quality coffee cordials constructed a laboratory-scaled dehydration unit that allows for the study of relative humidity of air in the dehydration patterns of parchment coffee. In addition, they are evaluating the extractive distillation method for the recovery of coffee aroma compounds in an ethanol-based solution. Projects geared to the development of new products based on local crops, such as the development of a fermented bread from cassava flour and a nutritional cream-cereal from pigeon peas, are already on a stage in which products are being evaluated on standard parameters and by sensory analysis.

At the same time, outreach activities geared to the local food industry have continued. More than 20 workshops have been offered on different aspects of food safety geared to different types of audiences: producers in the farm, processors and government officials. Several additional service contracts with local food industries were also established during the year. Program participants have also continued their search for external resources and have succeeded in some of the grant competitions.

2. Brief description of the target audience

- Extension Specialists and Agents
- Academic Programs Faculty
- Producers and Commodity Groups
- Consumers
- Federal and State Agricultural Agencies (PRDA, USDA/APHIS, USDA/ARS, USDA/NRCS).
- Food industry/Manufacturing

V(E). Planned Program (Outputs)

1. Standard output measures

2010	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: 2010
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2010	Extension	Research	Total
Actual	0	1	1

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of Courses, seminars and workshops offered on the topics covered by the Program

Year	Actual
2010	20

Output #2

Output Measure

- Number of projects or industry collaboration agreements established

Year	Actual
2010	17

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Total Number of Enterprises Impacted by the Program
2	Food Manufacturing Exports in million dollars
3	Food Manufacturing Imports in million dollars

Outcome #1

1. Outcome Measures

Total Number of Enterprises Impacted by the Program

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	30	50

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
701	Nutrient Composition of Food

Outcome #2

1. Outcome Measures

Food Manufacturing Exports in million dollars

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	4943	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The program attempts to positively impact the island's food industry-related economy. One of the measures of said economy is the amount of goods exported. The rationale is that the more we support the industry, the stronger it becomes. As a result, local industry can shift from production for the local market only to production for satisfying both the local an international markets.

What has been done
Provide technical support in the form of training and services to ensure compliance with quality standards, federal regulations and quality system requirements. Support local industry and commodity groups in the development process of new production lines and products. Perform research in identified areas of need.

Results
The program is impacting many businesses, and those businesses are making adjustments. Although data on exports is not yet available, we believe that the program is making significant progress.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
701	Nutrient Composition of Food

Outcome #3

1. Outcome Measures

Food Manufacturing Imports in million dollars

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2010	2900	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The program strives to influence the local food industry. With a decline in farmland and agricultural related employment, imports continue to supply most of the island's food. By continually interacting with industry, the program strives to shift the market from importing goods to producing them.

What has been done
Provide technical support in the form of training and services to ensure compliance with quality standards, federal regulations and quality system requirements. support local industry and commodity groups in the development process of new production lines and products. Perform research in identified areas of need.

Results
It has been estimated that Puerto Rico imports about 85% of the total food supply requirement. We strive to move the industry to a position where it can play a more important role in the local supply chain. Businesses are starting to ask about implementation of HACCP and quality management systems. Such a wave should strengthen the industry. As a consequence, the industry should be better prepared to seek protective marketing policies and regulations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service

701 Nutrient Composition of Food

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations

Brief Explanation

The economy of Puerto Rico continues to suffer from the economic recession affecting the rest of the world. The amount of funding available to invest in research or in funding new ventures is limited. Program activities during 2010 were also affected by strikes and other situations affecting the access to university facilities.

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

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}