2011 University of Puerto Rico Research Annual Report of Accomplishments and Results

Status: Accepted

Date Accepted: 05/22/2012

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 yet 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. Appropriations for this program were, however, indefinitely suspended by Congress during 2011. 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 FY2011 the Hatch allocation for Puerto Rico was $4,353,018. Along with state matching funds and other program income the actual dollars spent in our planned programs in FY2011 were $7,016,563.

Planned Programs Overview

During last year the PRAES continued to direct its research programs toward the solution of the most pressing problems identified by our stakeholders and faculty. More than sixty new projects were begun to address concerns related to a wide array of agrofood and natural resources problems, ranging from the impact of new invasive species on the productivity of crops, of rising prices for production inputs (fertilizers, feed, energy), and continued depletion or pollution of natural resources, to ways of improving our local food security and monitor/manage the effects of climate change.

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 2011 the PRAES allocated 11 FTE/SY and more than forty percent of our Hatch funds to this program. The experimental results generated by the four work groups active in the program (beef, dairy cattle, small ruminants, and swine) have contributed to the gradual refinement of a list of recommended management practices (RMP) which are emphasized in outreach activities with livestock producers by methods including field days and training sessions, seminars and conferences, group or individual consultations, and printed materials. Besides continuing with long-term efforts, such as the beef work group's development of a scheme for the classification of locally produced grass-fed beef as a means to differentiate it from imported beef and improve its market price, new projects were begun last year to assess the economic viability of alternative energy technologies for reducing the energy costs of milking parlors, to improve the quality of raw milk, and to optimize the use of anthelmintics effective for the control of nematodes in dairy heifers. Research and education activities have also continued on the development of new forage resources and on improving forage management practices geared towards supplying an important fraction of the nutrient requirements of ruminant livestock. Outreach efforts conducted during the year also emphasized on documenting the importance of this program for local food security, and on educating stakeholders on how policy frameworks addressing climate change will magnify the industries' problems, if recommended measures based on sound science are not adopted by both producers and policy decision-makers.

During 2011 PRAES **Integrated Management of New and Emerging Pests and Diseases** (IMNEP) program continued to use the available methods for disease recognition and identified the causal agents of emerging diseases affecting citrus, cucurbits, papaya, tomatoes, cilantro and tuberous crops. A pilot of an open access online database containing information on the powdery mildews of Puerto Rico was developed, which will allow for accurate species identification and will help to enforce quarantine regulations to halt the introduction of new species of pathogens. In addition, research geared towards the control of recently introduced pests and diseases is producing promising results. In the case of the Coffee Berry Borer (CBB), research suggests that the application of the fungus B. bassiana can decrease CBB population by 40%, and the liberation of the parasitoid Phymastichus coffea can account for another 20% control. The adoption of these biocontrol agents with other control measures in an integrated pest management program is estimated to reduce losses from the CBB from 20% ($4.4 million) to 12% ($2.6 million) at the farm level. In the case of citrus greening, natural enemies of the Asian Citrus psyllid, vector of the disease-causing bacterium Candidatus Liberibacter asiaticus, were identified. Findings on the dispersion of the disease in Puerto Rico were presented at two different national meetings with close to 200 participants. In the fulfillment of this program's goals the PRAES continued to work closely with the State Department of Agriculture, Agricultural Extension Service, USDA/ARS and APHIS/PPQ in the surveillance and identification of exotic pests and diseases in Puerto Rico. Several activities directed

toward assessing the most pressing crop protection issues faced by stakeholders were held last year, and steps were taken to translate these concerns into national recommendations to be adopted by the government when dealing with newly introduced pests and diseases. More than 21% of the new projects approved by PRAES last year, and 14 FTE/SY, were dedicated to 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. In Puerto Rico, lack of seed availability remained the single most important concern brought by stakeholders to our meetings of food crops commodities last year. To help palliate this acute need, active projects expanded the production and island-wide distribution of seed of improved cultivars developed over the years under this program. Both conventional and organically produced seed of tropical pumpkin, sweet corn, sweet potato, bean, pigeon peas, plantains, and other farinaceous crops, were produced and sold at PRAES substations. An estimate performed last year of the impact of seed sales at the Isabela substation concluded that the seed sold at the substation resulted in the generation of almost 14 million dollars in gross farm income in Puerto Rico during the past 10 years. In addition, to address stakeholder concerns related to increases in the price of production inputs, several projects began or continued work on alternative management practices that could be incorporated into conventional or organic production systems, and could potentially improve the economic viability of farm operations.

The PRAES continues to release improved germplasm of crops of importance for local and global food security. Among the improved germplasm released in 2011 were 'Beníquez', a white bean breeding line which combines resistance to several viruses, and yields as well as 'Verano'; the pink bean breeding line PR0401-259, which combines resistance to several viruses, common bacterial blight and web blight; and "Pujols" and "Camuy", two tropical type sweet potato cultivars. PRAES faculty with expertise in tropical food crops continues to make an important contribution to global food security through collaboration with international projects partially leveraged by matching formula funds. Last year improved bean cultivars, developed by collaborative efforts between Puerto Rico, Haiti, several Central American countries and Angola, were released and validated by on-farm trials in several of these countries. In 2011 the PGRBPS program engaged 18.7 FTE/SY and received twenty-five 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 on the environment and natural resources. During last year, the principal problems addressed by research under this program were associated with: (1) the development of pollution prevention and mitigation practices for soil and watershed protection and management, including behavior and fate of pesticides and other pollutants in soil and water and the use of biological indicators to assess watershed nutritional status; (2) the development of soil improvement and maintenance practices; (3) the development and promotion of sustainable agricultural practices; and (4) biological diversity research.

In the area of water quality, research directed towards the development of quantitative thresholds of nutrient impairment of watersheds and reservoirs has continued by exploring the use of benthic algae as a biological indicator of nutrient over-enrichment in watersheds. The results of these studies are expected to facilitate the development of biologically based guidelines for regulating nutrient over-enrichment in rivers of Puerto Rico. Studies of particular watersheds were also conducted to develop, through the use of hydrologic, watershed soil erosion and sediment transport models, the best management practices that could be implemented within the watershed to reduce soil erosion, and to reduce the amount of nutrients and sediments exported to ocean waters. Educational materials were also developed to inform community stakeholders about ways to avoid, minimize or eliminate the amount of sediment exported to the ocean as a result of soil disturbances in the catchment area of the watershed.

To address stakeholders' needs for better agricultural waste disposal methods, several multidisciplinary studies were conducted on proper organic resource management. Windrow composting of

various agricultural residues is one of the methods being validated and for which the know-how about composting processes is being shared through a Web page, and through field days and seminars.

Harmful non-native species pose a challenge that requires a decision-making framework based on the prioritization of species for their control, as well as regulatory and public education programs. New program efforts begun last year in this area are trying to incorporate ecological and economical data into status assessment analysis in order to guarantee a comprehensive approach towards implementation of management efforts. In addition, several multidisciplinary research studies have been performed to assess the impact of invasive species on agricultural and natural ecosystems. As a result, various management practices and methods have been evaluated.

The PRAES allocated 12.2 FTE/SY to this program during 2011. While more than forty percent of the projects were sponsored by non-formula funds, Hatch funds were vital to leverage the external funds.

In the **Agricultural Economics, Marketing, Value Added and Community Development** (AEMCD) program, the smallest in our research portfolio in terms of FTE and formula funds allocation, research was performed to determine consumer preferences, marketing margins, and farmers' and other participant's shares in the marketing channels of selected agricultural commodities. To asses the potential impact of alternative policies towards invasive species, spatially explicit simulations of the dispersal rate of two invasive plant species (Mimosa pigra and Melaleuca quinquenervia) in Puerto Rico were performed, with the overall goal of understanding and deciding on the best way to control their rate of spread. In collaboration with Extension faculty and agents, results deemed useful to farmers, community organizers, or government officials were disseminated to interested stakeholders by means of electronic media, publications, posters and presentations. The total FTE/SY dedicated to this program in 2011 was 3.1.

During 2011, improvements of building infrastructure, critical for the development of research in the Food Safety, Science and Technology (FSST) program, were completed. New faculty started writing research proposals, and industry collaboration started peaking. Towards the second half of the year a key agreement was signed with the Puerto Rico Industry Development Corporation (PRIDCO) to provide analytical services to their sponsored enterprises. However, because of budgetary restrictions, research activity during 2011 was largely limited to following up on the already initiated projects. Among these, a project that included postharvest quality maintenance factors of plantains and bananas was completed last year, and three other projects were initiated on edible films from local starchy crops and their application to food to prevent moisture loss and microbial deterioration.

Work has also continued in the evaluation of several methods to obtain essence extracts of coffee in an ethanol base. These extracts will be used in the formulation of value added products, such as coffee schnapps, that will combine the flavors and aroma of Puerto Rican coffee with highly recognized rums produced in Puerto Rico, thus increasing revenue opportunities for the Puerto Rican coffee industry. In addition, work on whey-based kefir was completed during 2011, resulting in three theses. Whey is one of the residues of milk processing operations of environmental and economic importance in the island. Last year another project on whey utilization was begun. Program participants have also continued their search for external resources and have succeeded in some of the grant competitions. The total FTE/SY devoted to this program in 2011 was 5.2.

As was the case during 2010, research and outreach activities conducted in 2011 in all of our programs continued to be developed in the context of an unrelenting economic recession in Puerto Rico, budget reductions, administrative restructuring, and a university-wide freeze of new faculty appointments. While still in the process of evaluating and making institutional structural adjustments to assure a more efficient system, in the conduct of our programs emphasis has been made in expanding communication with our stakeholders, on addressing their stated needs, and on strengthening long-standing partnerships with governmental and non-governmental organizations which share our goals and

with which resources could be pooled to enable a wider impact from programs' activities. In spite of the challenges, we hope that current efforts will help us to emerge with a stronger system, better positioned to meet Puerto Rico's current and future needs in agriculture, food, and in natural resources and environment conservation.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	55.1	0.0
Actual	0.0	0.0	64.2	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 PRAES 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

- Use of media to announce public meetings and listening sessions
- 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 continues 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. Meeting information is also posted in the AES website and is frequently printed in the local agricultural monthly newspaper. The Associate Dean sends personal invitations to relevant government officials and positional leaders of stakeholders groups. 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 have organized thematic workshops, seminars, and field days where research results have been shared and alternative views on the subject-including further research and extension needs, or public policy determinations--have been discussed. The feedback received in these activities continues to inform the currentprocess of program assessment for our rolling five-year POW.

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 were 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 groups
- Meeting with traditional Stakeholder individuals

Brief explanation.

Input from stakeholders is collected at the meetings convened by commodity and program leaders. Stakeholders are asked to fill a written evaluation at the end of the meeting which includes questions 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
- In the Action Plans
- 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 input received during past years from traditional and non-traditional stakeholders and from government officials were critical for starting a pilot organic experimental farm, for example, 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

· As has been already pointed out in our planned programs summary, the single most important concern brought about by stakeholders to our meetings of food crops commodities last year was the lack of seed availability. PRAES adopted the recommendation of stakeholders of expanding the production and distribution of improved cultivars developed over the years under our programs in our substations around the island, to help palliate this acute need.

· Stakeholders are also worried and in need of recommendations to manage the new pests and diseases plaguing Puerto Rico's most important commercial commodities of coffee, plantains and bananas, and citrus. For several years now we have been expanding our research activities related to the Coffeee Berry Borer, Black Sigatoka and Citrus Greening, among others. A new Certified Quarantine and Beneficial Insect Rearing Facility is expected to be fully operational by next year. We expect to enhance through this new laboratory our capacity to develop biological control technologies for invasives entering Puerto Rico or threatening the US thorough the Caribbean

pathway. This facility was only possible by the pooling of our resources with those of some of our long-term partners and stakeholders.

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	4353018	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	3769864	0
Actual Matching	0	0	3053571	0
Actual All Other	0	0	193128	0
Total Actual Expended	0	0	7016563	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	40274	0

V. Planned Program Table of Content

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			10%	
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			10%	
307	Animal Management Systems			10%	
308	Improved Animal Products (Before Harvest)			10%	
311	Animal Diseases			5%	
313	Internal Parasites in Animals			5%	
601	Economics of Agricultural Production and Farm Management			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	10.5	0.0
Actual Paid Professional	0.0	0.0	11.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	1673757	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1034793	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	193128	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research pursuing diverse objectives was conducted with the following classes of farm animals by the scientific personnel participating in this program and their students: (1) beef work group, (2) dairy cattle work group, (3) overlapping small ruminants and forages groups, and (4) swine. The experimental results generated have contributed to the gradual refinement of a list of recommended management practices (RMP) which are emphasized in outreach activities with livestock producers by methods including field days and training sessions, seminars and conferences, group or individual consultations, and printed materials.

In the beef work group efforts have continued toward the development of a scheme for the classification of locally produced grass-fed beef as a means to differentiate it from imported beef, with the expectation that it will eventually result in better prices being paid to local producers. Research and education activities have also continued on the development of new forage resources and on improving forage management practices geared towards supplying an important fraction of the nutrient requirements of ruminant livestock.

To achieve a broader participation of program stakeholders in the identification of their information needs, several commodity-focused meetings were held at different locations around the island. In these meetings research priorities were re-examined and validated or modified according to the changing concerns of the audience. Outreach efforts conducted during the year also emphasized on documenting the importance of this program for local food security, and on educating stakeholders on how policy frameworks addressing climate change will magnify the industries' problems, if recommended measures based on sound science are not adopted by both producers and policy decision-makers.

2. Brief description of the target audience

(1) Commercial-scale producers of milk, dairy replacement heifers, bovines for meat, sheep and goats, swine, rabbits, fowl for meat and eggs, and forages
(2) Agricultural Extension Service specialists and county agents
(3) Puerto Rico Department of Agriculture and USDA personnel
(4) Public policy makers
(5) Farm Credit Service and other financial sector personnel

(6) Private sector professionals such as consultants and sales people
(7) Faculty and graduate and undergraduate agricultural students of UPR-Mayagüez and UPR-Utuado
(8) Vocational Agriculture High School students
(9) General public and mass media

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2011	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: 2011
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2011	Extension	Research	Total
Actual	0	16	16

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
2011	4

Output #2

Output Measure

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

Year	Actual
2011	2

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
2011	4

Output #4

Output Measure

- Number of publications made in refereed scientific journals.

Year	Actual
2011	16

Output #5

Output Measure

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

Year	Actual
2011	15

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	Actual
2011	46

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 don't have a reliable measure of RMP adoption in all work groups, evaluation results provided by the Extension Dairyman for his 2011 educational activities show that 86.8% of participants responded that their willingness to adopt the demonstrated practices was considerable.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
306	Environmental Stress in Animals

307 Animal Management Systems
308 Improved Animal Products (Before Harvest)

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
- Public Policy changes
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)
- Other (See text)

Brief Explanation

One of the hoped-for outcomes projected for the year 2011 was a modest increase in aggregate on-farm value of all livestock production in Puerto Rico. This increase failed to occur; among the principal negative factors that prevented it were: (a) few funds available for government incentive programs, (b) constantly increasing cost of the necessary inputs for livestock production, (c) competition from unregulated importation of products of animal origin, (d) inadequate marketing arrangements for local products, (e) small profit margins for producers, (f) idle farmland and loss of land to non-agricultural uses, (g) retirement of older producers and insufficient numbers of young people interested in undertaking productive agriculture, (h) adverse weather conditions, especially excessive rain and flooding in some areas.

Factors affecting our research and outreach efforts aimed at fostering positive outcomes to improve food security in Puerto Rico included a notably tight budget situation of the University of Puerto Rico and diminished human resources. In 2011 the Department of Animal Industry lost to retirement one scientist specialized in beef cattle management and its relation to meat quality, one extension specialist in swine production , and one veterinarian of the teaching Staff who also lent supportto research and extension efforts with swine. Additionally, the Agricultural Extension Service is undergoing a process of contraction; too few collaborators are available to visit producers' farms and follow up on implementation of RMP.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

No formal evaluation results are yet available.

Key Items of Evaluation

No formal evaluation results are yet available.

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			21%	
212	Pathogens and Nematodes Affecting Plants			30%	
213	Weeds Affecting Plants			2%	
215	Biological Control of Pests Affecting Plants			21%	
216	Integrated Pest Management Systems			26%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	14.1	0.0
Actual Paid Professional	0.0	0.0	14.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	485771	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	342319	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 2011 PRAES continued to use the available methods for disease recognition and identified the causal agents of emerging diseases affecting citrus, cucurbits, papaya, tomatoes, cilantro and tuberous crops. The characterization of Squash Vein Yellowing Virus (SqVYV),a novel whitefly-transmitted potyvirus, was a major breakthrough. Ralstonia solanacearum race 1 in tomatoes and Pythium coloratum in cilantro were identified with PCR, Hi-Fidelity and sequencing of the internal transcribed spacer regions of nuclear ribosomal DNA. Advances in the studies of powdery mildews resulted in the identification of Oidium caricae,and Oidium sp. Podosphaera xanthii was found infecting various species of cucurbits on the island. For the first time Podosphaera fusca was identified causing powdery mildew in okra, Abelmoschus esculentus. Eryshiphe heraclei, E. peruviana,E. quercicola and Podosphaera fusca are new reports for Puerto Rico. A pilot of an open access online database containing information on the powdery mildews of Puerto Rico was also developed, a database which will allow for accurate species identification and will help to enforce quarantine regulations to halt the introduction of new species of pathogens.

In addition, research geared towards the control of recently introduced pests and diseases is producing promising results. In the case of the Coffee Berry Borer (CBB), research suggests that the application of the fungus B. bassiana can decrease CBB population by 40%, and the liberation of the parasitoid P.coffea can account for another 20% control. These results will help in promoting the use of biocontrol agents of the CBB in combination with other control measures in an integrated pest management program. The impact of the biocontrol measures to control the CBB is estimated in a reduction of losses from 20% ($4.4 million) to 12% ($2.6 million) at the farm level.

In the case of citrus greening (CG), naturalenemiesof the Asian Citrus psyllid(ACP),vectorof the disease-causing bacterium,were identified.Field studies will continue to determine the most effective and least detrimental insecticide for the control of the ACP. Several workshops for citrus stakeholders, given in coordination with Extension Specialists, emphasized the importance of quick identification and appropriate management of the disease. More than 30 citrus nurseries and orchards were visited to collect samples for disease detection and to promote the adoption of practices to reduce the potential of CG. Findings on the dispersion of the disease in Puerto Rico were presented at two different national meetings with close to 200 participants.

In the fulfillment of this program's goals the PRAES continued to work closely with the State Department of Agriculture, USDA/ARS and APHIS/PPQ in the surveillance and identification of exotic pests and diseases in Puerto Rico. Several activities directed toward assessing the most pressing crop protection issues faced by stakeholders were held last year, and steps were taken to translate these concerns into national recommendations to be adopted by the government when dealing with newly introduced pests and diseases.

2. Brief description of the target audience

- Extension Specialists and Agents
- Academic Programs Faculty and Students
- Producers and Commodity Groups
- Consumers

•Federal and State Agricultural Agencies (PRDA, USDA/APHIS, USDA/ARS, USDA/NRCS)

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2011	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: 2011
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2011	Extension	Research	Total
Actual	0	6	6

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2011	2

Output #2

Output Measure

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

Year	Actual
2011	3

Output #3

Output Measure

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

Year	Actual
2011	3

Output #4

Output Measure

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

Year	Actual
2011	21

Output #5

Output Measure

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

Year	Actual
2011	17

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
2011	6

Output #7

Output Measure

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

Year	Actual
2011	8

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	Actual
2011	150

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Collaborative efforts between researchers and extensionists 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 material 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) continued to work closely with seed companies in the detection of diseases regarding quarantine pathogens in several crops.

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 areas. In the PDC more than 4,000 determinations were conducted in the samples submitted.

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	Actual
2011	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 in sustaining banana, plantain, and coffee production on the island.

What has been done
In Black Sigatoka(BS), 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 and the liberation of parasitoids were devised. Seminars were presented to farmers, agronomists and field inspectors.

Results
The study performed with the CBB indicated that Beauveria bassiana and Phymastichus coffea can effectively produce mortality of 60 percent of the 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

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

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)

Evaluation Results

No formal evaluation results are yet available.

Key Items of Evaluation

No formal evaluation results are yet available.

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 FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	17.0	0.0
Actual Paid Professional	0.0	0.0	18.7	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	954465	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1162317	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

Lack of seed availability remained the single most important concern brought by stakeholders to our meetings of food crops commodities last year. To help palliate this acute need, active projects expanded the production and island-wide distribution of seed of improved cultivars developed over the years under this program. Both conventional and organically produced seed of tropical pumpkin, sweet corn, sweet potato, bean, pigeon peas, plantains, and other farinaceous crops, were produced and sold at PRAES substations. Last year, an estimate of the impact of seed sales at the Isabela substation concluded that the seed sold at the substation resulted in the generation of almost 14 million dollars in gross farm income in Puerto Rico during the past 10 years. Sales of squash, bean and pigeon pea seed had the greatest economic impact.

Among the improved germplasm released in 2011 were 'Beníquez', a white bean breeding line which combines resistance to several viruses, and yields as well as 'Verano'; the pink bean breeding line PR0401-259, which combines resistance to several viruses, common bacterial blight and web blight; and the black bean breeding line PR0650-31, which combines resistance to Bean Common Mosaic Virus, common bacterial blight, and web blight. Also released last year were "Suresweet 11", an open pollinated sweet corn cultivar, and "Pujols" and "Camuy", two tropical type sweet potato cultivars. In addition, PRAES faculty with expertise in tropical food crops continues to make an important contribution to global food security through collaboration with international projects partially leveraged by formula funds. Last year improved bean cultivars, developed by collaborative efforts between Puerto Rico, Haiti, several Central American countries and Angola, were released and validated by on-farm trials in several of these countries.

To address stakeholder concerns related to increases in the price of production inputs, several projects began or continued work on alternative management practices that could be incorporated into conventional or organic production systems, and could potentially improve the economic viability of farm operations. Projects focused on alternative fertilizers that could possibly reduce the use of chemical fertilizers, and also focused on other agronomic practices that, as part of an integrated approach, could probably satisfy crop needs and optimize fertilizer use.

Program participants actively disseminated information and project results through conferences, field days, oral presentations, radio programs, and electronic and paper publications. Visits to demonstration sites were particularly stressed by collaborators in organic projects, and interest from students, farmers and community stakeholders remained high. While scientific publications in peer reviewed journals were below our expectations, the increased volume of presentations at scholarly meetings will probably translate into more refereed contributions in future years.

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.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2011	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: 2011

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2011	Extension	Research	Total
Actual	0	12	12

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of stakeholders to adopt the proposed BMPs.

Year	Actual
2011	130

Output #2

Output Measure

- Focus groups of collaborators' opinion of the new technologies being validated
  Not reporting on this Output for this Annual Report

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
2011	3000

Output #4

Output Measure

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

Year	Actual
2011	250

Output #5

Output Measure

- Number of participants at the field days coordinated with Extension

Year	Actual
2011	456

Output #6

Output Measure

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

Year	Actual
2011	100

Output #7

Output Measure

- Number of refereed publications

Year	Actual
2011	12

Output #8

Output Measure

- Number of non-refereed publications

Year	Actual
2011	23

Output #9

Output Measure

- Number of presentations in scientific meetings

Year	Actual
2011	25

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	Actual
2011	130

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. An estimate performed last year of the impact of seed sales at the Isabela substation concluded that the seed purchased there resulted in the generation of almost 14 million in gross farm income in Puerto Rico during the past 10 years. The number of stakeholders, especially farmers, attending activities sponsored by the Puerto RAES 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	Actual
2011	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 2011. 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

Brief Explanation

Factors affecting our performance in 2011 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, while others were overestimated. Hopefully, the gradual implementation of a more formal evaluation component, included in our 2013 Plan of Work, will improve the reliability of our estimates.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

No formal evaluation results are yet available for this program.

Key Items of Evaluation

No formal evaluation results are yet available for this program.

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
101	Appraisal of Soil Resources			4%	
102	Soil, Plant, Water, Nutrient Relationships			14%	
111	Conservation and Efficient Use of Water			2%	
112	Watershed Protection and Management			18%	
123	Management and Sustainability of Forest Resources			13%	
133	Pollution Prevention and Mitigation			22%	
136	Conservation of Biological Diversity			10%	
211	Insects, Mites, and Other Arthropods Affecting Plants			9%	
216	Integrated Pest Management Systems			3%	
403	Waste Disposal, Recycling, and Reuse			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	9.5	0.0
Actual Paid Professional	0.0	0.0	12.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	549830	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	434529	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

Research

Current research efforts conducted by faculty, staff, and students at the College of Agricultural Sciences University of Puerto Rico, Mayagüez Campus on this programmatic area are associated with: (1) the development of pollution prevention and mitigation practices for soil and watershed protection and management including behavior and fate of pesticides and other pollutants (agricultural residues) in soil and water and the use of biological indicators to assess watershed nutritional status; (2) the development of soil improvement and maintenance practices; (3) the development and promotion of sustainable agricultural practices; (4) biological diversity research (particularly on the effects of non-native species on biodiversity; on management approaches for conserving and restoring biodiversity; and on the impact of agricultural management practices on natural ecosystems).

Outreach/Education:

This research program has for many years played a distinctive and integral role in educational outreach activities sponsored by the College of Agricultural Sciences. Research initiatives and results are disseminated through activities such as (1) publication of research results in bulletins, newspaper articles, and popular magazines for farmers and in refereed journals for scientists; (2) development of educational materials for stakeholders interested in the management and preservation of natural resources and agricultural sustainability; (3) dissemination of research results through publications, seminars, farm/field day visits, workshops, conferences, websites, exhibitions and any other method deemed appropriate to reach our target audiences; and (4) development of strategies and programs to increase community involvement. Such activities provide us a means to meet with thousands of individuals and to provide information concerning the different research projects associated with this programmatic area.

2. Brief description of the target audience

Extension specialists and professionals graduate and undergraduate students, government partners, producers, consumers, environmental groups and community groups.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2011	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: 2011

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2011	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
2011	29

Output #2

Output Measure

- Number of Peer Reviewed publications.

Year	Actual
2011	7

Output #3

Output Measure

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

Year	Actual
2011	22

Output #4

Output Measure

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

Year	Actual
2011	6

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 persons adopting invasive species management practices
8	Number of stakeholders gaining knowledge on pollution prevention and mitigation practices for soil and watershed protection and management.
9	Number of stakeholders gaining knowledge on the impact of aquatic weeds and management practices on agricultural water systems.
10	Number of stakeholders gaining knowledge on invasive species management practices.

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	5000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Education as a first line of defense for the conservation and management of natural resources.

What has been done
Research activities in this area have been varied and performed across disciplines, particularly in interdisciplinary groups.

Results
Several projects addressing the importance of natural resources and management have been developed. Research results have been successfully disseminated, mainly through web sites and blogs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
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
403	Waste Disposal, Recycling, and Reuse

Outcome #2

1. Outcome Measures

Number of farmers adopting microirrigation management practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	40

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

Outcome #3

1. Outcome Measures

Number of persons adopting practices that prevent biodiversity threats and losses

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	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
123	Management and Sustainability of Forest Resources
136	Conservation of Biological Diversity
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #4

1. Outcome Measures

Number of farmers adopting methods to increase soil organic matter content

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	3000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The need for better methods for agricultural waste disposal and management as an opportunity to increase soil organic matter content.

What has been done

Several multidisciplinary research studies have been performed in order to develop better waste disposal and increase soil organic matter content.

Results
Agricultural waste disposal and recycling practices have been developed for crops such as coffee and for dairy farms. Research results have been successfully disseminated mainly through web sites and blogs.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Number of farmers reporting increased water use efficiency in their farms

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Number of persons that adopted practices to improve water resources.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
USEPA mandate to develop quantitative thresholds of impairment of nutrient for watersheds and

reservoirs. The target audiences of this project are the local regulatory agencies in charge of water quality protection such as the Environmental Quality Board and Department of Natural and Environmental Resources.

What has been done
Training, workshops and research demonstrations have been performed; these have reached a wide variety of audiences.

Results
The expectation is that attendees have been adopting the conservationist practices learned. The determination of the current nutrient status of rivers in Puerto Rico is a key element to develop water quality guidelines for the establishment of sound pollution prevention and management practices for watershed protection.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #7

1. Outcome Measures

Number of persons adopting invasive species management practices

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Number of stakeholders gaining knowledge on pollution prevention and mitigation practices for soil and watershed protection and management.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	290

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
USEPA mandate to develop quantitative thresholds of impairment of nutrients for watershed and reservoirs. The target audiences of this project are the local regulatory agencies in charge of water quality protection such as the Environmental Quality Board and the Department of Natural and Environmental Resources.

What has been done
In order to define a biological index for nutrient impairment conditions in rivers and streams of Puerto Rico, a research project was developed to assess the use of benthic algae as a biological indicator of nutrient over-enrichment in watersheds.

Results
The research group completed a study where a set of reference criteria for nutrients, i.e. quantitative thresholds, were defined for rivers in the island. The combined results of studies completed and in process should facilitate the development of biologically based guidelines for regulating nutrient overenrichment in rivers and streams of Puerto Rico. Four seminars were presented to different audiences (e.g., students, personnel of regulatory agencies); the mean number of attendance was 73.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #9

1. Outcome Measures

Number of stakeholders gaining knowledge on the impact of aquatic weeds and management practices on agricultural water systems.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	650

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The need for better methods to assess the impact of aquatic weeds, particularly non-native species and management practices in agricultural water systems.

What has been done
Several research studies have been performed in order to assess the impact of aquatic weeds, particularly non-native species, and management practices in agricultural water systems.

Results
Research results have been successfully disseminated mainly through web sites, blogs, seminars, workshops and fact sheets.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation
216	Integrated Pest Management Systems

Outcome #10

1. Outcome Measures

Number of stakeholders gaining knowledge on invasive species management practices.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	300

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The impact of native or non-native invasive species problem poses a serious challenge that requires a decision-making framework based on the prioritization of species for their control, as well as regulatory and public education programs.

What has been done

Several multidisciplinary research studies have been performed in order to assess the impact of invasive species on agricultural and natural ecosystems. Invasive species management practices and methods have been evaluated.

Results
Research results have been successfully disseminated mainly through web sites, blogs, seminars, workshops and fact sheets. Training, workshops and research demonstrations have been performed; a wide variety of audiences have been reached. The expectation is that attendees have been gaining knowledge about the impact and management of the invasive species.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
136	Conservation of Biological Diversity
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

Budget reductions at the university and increases in the cost of higher education for students may affect the number of scientists and graduate students working under this program.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

No evaluation has been performed for this cycle.

Key Items of Evaluation

No evaluation has been performed for this cycle.

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			33%	
604	Marketing and Distribution Practices			31%	
606	International Trade and Development			9%	
607	Consumer Economics			19%	
608	Community Resource Planning and Development			3%	
610	Domestic Policy Analysis			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.0	0.0
Actual Paid Professional	0.0	0.0	3.1	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	43756	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	41106	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

Research was performed to determine consumer preferences, marketing margins, and farmers' and other participant's shares in the marketing channels of selected agricultural commodities. Also, studies were conducted to identify the diverse strategies that local food system stakeholders are currently using or might use to create and manage ongoing or potential change. Within the latter activity, the information needs of stakeholders were also assessed. Spatially explicit simulations of the dispersal rate of two invasive plant species (Mimosa pigra and Melaleuca quinquenervia) in Puerto Rico were performed, with the overall goal of understanding and deciding on the best way to control their rate of spread. In collaboration with Extension faculty and agents, results deemed useful to farmers, community organizers, or government officials were disseminated to interested stakeholders by means of electronic media, publications, posters and presentations.

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2011	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: 2011

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2011	Extension	Research	Total
Actual	0	1	1

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of refereed publications

Year	Actual
2011	1

Output #2

Output Measure

- Number of presentations in scientific meetings

Year	Actual
2011	14

Output #3

Output Measure

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

Year	Actual
2011	13

Output #4

Output Measure

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

Year	Actual
2011	130

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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	Actual
2011	437

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

Outcome #2

1. Outcome Measures

Number of stakeholders gaining knowledge about the economic and managerial aspects of environmental and natural resource issues

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- 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)

Evaluation Results

No formal evaluation results are yet available for this program.

Key Items of Evaluation

No formal evaluation results are yet available for this program.

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			21%	
502	New and Improved Food Products			19%	
503	Quality Maintenance in Storing and Marketing Food Products			31%	
701	Nutrient Composition of Food			21%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			1%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			7%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.0	0.0
Actual Paid Professional	0.0	0.0	5.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	62285	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	38507	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 2011, the final touches on building infrastructure improvements were completed. New faculty started to write research proposals, and industry collaboration started to peak. Towards the second half of the year, a new temporary contract was offered to a new faculty member to work on food nanotechnology, and a key agreement was signed with the Puerto Rico Industry Development Corporation (PRIDCO) to provide analytical services to their sponsored enterprises. Yet, changes in the administrative structure of the University lead to the resignation of the Food Safety, Science, Technology and Childhood Obesity (FoSSTCo) Program Coordinator who also acted as Associate Coordinator of the Food Science and Technology (FST) academic program. Because of budgetary restrictions, both positions remained vacant throughout most of 2011. Therefore, activity during 2011 was largely limited to following up on the already initiated projects. To date, the position of FoSSTCo Coordinator remains vacant while AES Administration evaluates the most needed organizational structure update to properly address present and upcoming challenges. On the positive side, however, the close tie between the FoSSTCo and FST programs benefited from the newly implemented curricular sequence for undergraduates. Said sequence consists of 15 credits of FST courses that appear on the academic transcript as a declared minor concentration. Student participation in the sequence spiked interest on undergraduate research to address identified priority areas.

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2011	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: 2011

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2011	Extension	Research	Total
Actual	0	5	5

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
2011	13

Output #2

Output Measure

- Number of projects or industry collaboration agreements established

Year	Actual
2011	10

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
4	Number of improvement or development projects focused on safety or nutritional aspects of product or production processes
5	Number of projects strengthening the market through the development or adaptation of postharvest and/or packaging technology
6	Number of projects focusing on definition of quality parameters for fresh and processed goods, including chemical properties, safety and nutritional value
7	Number of projects dealing with residues, wastes, or effluents for the development of value added goods

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	Actual
2011	60

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
701	Nutrient Composition of Food

Outcome #2

1. Outcome Measures

Food Manufacturing Exports in million dollars

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Food Manufacturing Imports in million dollars

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of improvement or development projects focused on safety or nutritional aspects of product or production processes

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It has been estimated that PR imports approximately 85% of the total food it consumes. Thus, there is a need for increased agricultural and food processing activity on the island. Yet food production has to ensure safety and nutrition so as to ensure proper nourishment of consumers and to reduce the incidence of childhood obesity and related diseases.

What has been done
Most student research projects include safety and nutrition components of the food they work with. Also, with the initiation of the undergraduate curricular sequence in FST, several undergraduate research projects dealt with the development of commercial food products based on the local agriculture-derived goods. Furthermore, during the second half of 2011, the FST program initiated efforts towards commercialization of previously developed products resulting from an annual internal competition in commercial food product development.

Results
Our first commercial product is almost ready for commercialization. In fact, it should reach retail establishments during the first half of 2012. Two theses were also completed focusing on product development and functional components, respectively. Finally, ten students participated in

undergraduate research projects dealing with product development leading to completed works or efforts that will continue during 2012.

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
701	Nutrient Composition of Food
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #5

1. Outcome Measures

Number of projects strengthening the market through the development or adaptation of postharvest and/or packaging technology

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Literature reports improper postharvest practices as a main contributor to product losses and quality deteriorations. Puerto Rico producers need to pay particular attention to management and handling practices after harvest if we are to seriously address food security issues. In terms of packaging technology, there are food- and non-food related issues to address. On the food side, proper packaging ensures product safety and quality during transport, storage and distribution. On the non-food side, packaging adds up to the current waste disposal challenges faced by the island.

What has been done
A project was completed during 2011 that included postharvest quality maintenance factors of bananas and plantains, commodities of economic importance in Puerto Rico. Three other

projects were also initiated on edible films from local starchy crops and their application to food to prevent moisture loss and microbial deterioration. These projects continue during 2012.

Results
The banana and plantain project was completed, but publications have not yet been submitted. Projects on edible films provided data and experience to submit a project proposal that received funding for 2012

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
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #6

1. Outcome Measures

Number of projects focusing on definition of quality parameters for fresh and processed goods, including chemical properties, safety and nutritional value

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Product quality is defined by a combination of three forces: consumer expectations, regulatory agency requirements, and internal desires of the company. In Puerto Rico, it is generally recognized that quality attributes of agricultural goods from the island differ from those listed in USDA quality grades. Yet farmers have not assigned priority to the identification and measurement of objective quality attributes to develop standards, with the exception of the meat industry.

What has been done
Through many years, meat (i.e., pork and beef) related research was directed towards the

development of animal breeds of high conversion ratios (pounds of feed to pounds to meat). In recent years, researchers are starting to look at meat quality of those animals and how these measure up to USDA standards and imported meat quality.

Results
Two graduate students are working on issues related to meat quality determination; both should finish in 2012.

4. Associated Knowledge Areas

KA Code	Knowledge Area
503	Quality Maintenance in Storing and Marketing Food Products
701	Nutrient Composition of Food

Outcome #7

1. Outcome Measures

Number of projects dealing with residues, wastes, or effluents for the development of value added goods

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2011	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The potential for reutilization of residues, wastes or effluents from agricultural or food processing operations is well recognized and documented. In Puerto Rico, most of such residues end up in landfills, on compost piles or as animal feed. One of the residues of environmental and economic importance is whey. There are also residues from animal processing or fresh fruit and vegetable operations that can be utilized to generate further income and employment.

What has been done
For several years now, our dairy products expert has injected energy into the development of new products based on whey as a replacement for milk. Also, with the start of commercialization projects, interest spiked among faculty and graduate students to work with residues.

Results

Work on whey-based kefir was completed during 2011, resulting on three theses (2007, 2010 and 2012). During 2011 another project on whey utilization began and is underway. The third project, also began in 2011, focuses on the utilization of a specific non-commercial, yet naturally abundant, variety of mango to produce pectins.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Competing Programmatic Challenges

Brief Explanation

Economy - Puerto Rico is currently suffering the economic recession affecting the rest of the world. Although it is expected for the economy to pick up, while the recession prevails, the amount of funding available to invest in research or new ventures will be limited.

Competing programmatic challenges - Program resources are not dedicated to the program. Instead, they belong to other departments and they need to address issues as their respective programs so require. Thus, we have a pool of researchers who are constantly entering and leaving

V(I). Planned Program (Evaluation Studies)

Evaluation Results

No formal evaluation results are yet available for this program.

Key Items of Evaluation

No formal evaluation results are yet available for this program.