

2009 University of Puerto Rico Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The University of Puerto Rico Agricultural Experiment Station (AES) 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 AES 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 AES and the Puerto Rico Agricultural Extension Service have opted to continue with separate submissions, all of our planned programs incorporate 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 AES 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 AES 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 AES participates in both multistate research and Special Grants from USDA-NIFA that target agriculture in the Caribbean Basin of the United States.

Until the present POW, research efforts in the AES 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. During the initial years, programs were conceptualized around the situation and priorities of the area, but taking into account mostly the inputs and outputs from our Hatch and McIntire Stennis projects. For this reason some of the planned and actual outputs reported in 2007 appeared to be low. FY 2008 was the first year in which we incorporated into our annual report the outputs and FTE's contributed by most of our research projects. As a result, in 2009 some programs showed again significant increases from the 2007 planned targets for outputs and outcomes. During 2010, however, we will once more reorganize the administrative structure of research and the focus of programs under new categories, both to facilitate reporting under the new NIFA Guidance and to convey the message that we need to evaluate, provide continuity, and recontextualize our efforts to better meet changing local and global needs.

Core funding for the Agricultural Experiment Station's research program is provided by various sources. State funds are primarily used to cover salaries of academic and support personnel. USDA funding is crucial for directly financing the research program and supplementing salaries of faculty and staff. Formula-funds include Hatch Regular, Hatch Regional, McIntire-Stennis and Animal Health, although we have not had an active Animal Health project since 2005. Special Grants such as the Tropical and Subtropical Agriculture Research (T-STAR Caribbean) support targeted areas of research important for Puerto Rico, Florida and the Virgin Islands. Along with federal and state funding, there are extramural research grants and contracts such as those with the Natural Resources Conservation Service, Environmental Protection Agency, USDA-ARS, Puerto Rico's Department of Agriculture, Puerto Rico's Department of Natural Resources and other agreements with US-Universities and private donors. For FY2009 the Hatch allocation for Puerto Rico was \$4,088,274. Along with state matching funds and other program income the actual dollars spent in our planned programs in FY2009 was \$8,681,162.

Planned Programs Overview

The Milk and Meat Production Systems program has the primary purpose of supporting the commercial livestock industries of the island, of which the production of bovine milk, and broiler and bovine meat are the leaders. During 2009 the AES allocated 10 FTE/SY and more than half of our Hatch funds to this program. Current research is directed toward alleviating the inordinate dependence of local animal production on imported concentrate feed. In the case of dairy farms, feed costs represent 42% of cash expenses of operators. Important priorities in this area are therefore to improve the management of pastures to maximize the quantity and quality of forage produced; and to evaluate the best varieties of pastures adapted to the tropics. Last year we witnessed how several of our recommendations were being adopted by producers. One commercial forage producer planted 4 hectares of *stylosanthes* and produced hay of a quality comparable to that of imported alfalfa, for which he was paid the same price. The same farmer also planted 16 hectares of forage sorghum

that was harvested for haylage production in February, 2010. Another forage producer adopted the use of alternative nitrogen sources (liquid urea and poultry litter) for fertilizing grass forages. A further success was the funding by the Commonwealth Department of Agriculture of an infrastructure project to assist farmers with pasture establishment.

In the case of beef, one of the principal concerns of the industry is the low net return in cow-calf and cattle feeding operations. In addition, the industry has never established a quality grading system to offer consumers a product with a quality assurance. The void left between local consumption and local production is filled by imported graded and branded beef. To regain lost market participation, producers need to add value to their beef by differentiating it from the imported product. To support farmers in this endeavor, research is emphasizing on the development of economic feeding systems that can decrease slaughtering age of grass-fed cattle, characterizing the chemical composition and nutritional value of local beef, and using genetic markers to assist selection of beef cattle for meat tenderness. In conjunction with the Agricultural Extension Service and producers associations, an educational campaign targeting consumers on the nutritional value of locally-produced beef was begun last year. We expect that the establishment of a quality grading system will help to organize the market, increase beef cattle prices, and build up consumer confidence and demand for the local product.

During 2009 significant accomplishments were achieved in pest and disease characterization within our Integrated Management of New and Emerging Pests (IMNEP) program. The implementation of molecular diagnostics led to the identification of *Candidatus liberibacter asiaticus*, *Clavibacter michiganensis* subsp. *michiganensis* and of new mites and thrips species in Puerto Rico. As a follow up of an initiative begun last year to coordinate more closely research and extension work in this area, a collaborative effort with the Extension Service was begun to determine the spread of citrus greening, and a working group was organized to prepare an emergency response. Workshops were conducted in several municipalities to raise awareness of existing practices that may affect disease outbreaks, to enhance prevention measures to decrease the spread of the disease, and to stress the importance of using disease-free plants. We have also continued our participation within the Southern Plant Diagnostic Network (SPDN). Over 4,000 determinations have been conducted at the Disease Clinic in Juana Diaz aided by the SPDN; this aid has definitely improved our capacity to make timely recommendations to farmers regarding disease outbreaks.

In addition, more than one hundred farmers received research-based information about the integrated management of Black Sigatoka (BS) with selected appropriated fungicides for improved control. BS represents the most serious threat for the production of bananas and plantains in the island because local production relies on highly susceptible germplasm. While efforts are underway to identify and evaluate resistant varieties, alternatives to manage the disease have also being devised.

In general, program participants believe that at this stage it is difficult to provide an overall assessment of how all these initiatives are reducing farmers' losses due to emerging diseases and pests. Researchers and collaborators trust, nonetheless, that the analyses performed of diseases of quarantine significance for 8 different crops provide a framework for emergency responses in case of new disease introductions, therefore decreasing the risks of losses due to new diseases. During 2009 the AES allocated 14.1 FTE/SY to address the IMNEP program's goals.

The Plant Genetic Resources, Breeding and Production Systems Program continued last year with activities related to the selection and purification of germplasm of traditional crops, to the development of improved cultivars, and to the distribution of germplasm to farmers, scientists and the general public. It engaged 17.7 FTE/SY and received about a quarter of our Hatch funds. We continued to experience notable progress in hosting activities for stakeholders. A forum on research and education in organic farming attracted over 200 participants. Field days were conducted, in collaboration with the Extension Service, by the fruits, grain, roots and tubers, vegetable, and plantains and bananas commodity groups. In these field days Best Management Practices (BMPs) and newly developed varieties were shown for several crops. More than 1,800 copies of technological packages and bulletins describing BMPs for local crops were also distributed, and seeds and setts of improved varieties adapted to local conditions of more than fifteen crops were sold.

On-farm research to validate new technologies also continued last year with trials to evaluate nitrogen fertilization in maize grown for seed production. With the cooperation from the Extension Service, advanced genetic lines of sweet potato developed by the AES were planted in selected farmer's fields throughout several municipalities, to validate their performance in a commercial setting.

Last year there were also notable increases in the number of publications and presentations based on research results under this program. Twenty-one articles were published in refereed journals by the program's faculty and their graduate students, while fifty-four presentations were delivered at scientific meetings. This program's research agenda is directly linked to current food security concerns and since some crop traits under study, such as heat tolerance, address anticipated problems related to climate change, we may be adjusting its output measures in the future to better stress its contributions to these areas.

The Natural Resources and Environment research program supports the Puerto Rico Department of Agriculture and the Department of Natural Resources in the management of agricultural practices by conducting the following activities: (1) development of sustainable practices for watershed protection and management (2) development of management practices for soil erosion (3) establishment of biological indexes of contamination, and (4) sponsor forestry research, particularly in the areas of reforestation and protection of forests against fire and other threats. Several research projects conducted under this program were finished last year. Results from these projects were submitted for publication and were disseminated to our targeted audiences through meetings, field days, a seminar series, and other means.

On the area of water quality and ecosystem integrity, results of one of our projects suggest that the status of our reservoirs, currently listed as impaired because of a violation of the dissolved oxygen (DO) aquatic life criteria, may be based on a flawed understanding of the mechanisms controlling DO dynamics in tropical reservoirs. The initial results of this project tend to support the research team hypothesis that hypolimnion anoxia in Puerto Rico is largely a temperature-controlled phenomenon and cannot be used as an index of trophic status or reservoir impairment. Recently, researchers were able to link a significant fish kill event at La Plata reservoir to the effect of anoxia. Government agencies have become more aware of the impact of hypolimnion anoxia and are considering investing, at least on a trial basis, in some type of oxygenation/aeration system to evaluate its effect on water quality and fish habitat restoration. Results from this project are critical for guiding this important decision-making process.

Important progress has also been made towards devising a solution to the environmental problem caused by coffee hull disposal. Researchers have been able to develop a high quality stable compost produced from coffee hull, useful for plant propagation and general ornamental and gardening use. The compost has been made available to nearby communities of the Adjuntas Experimental Substation, in the coffee region, and demand already equals or exceeds the current capacity of the production plant.

Significant achievements have been made regarding the protection of our dry forest cacti from invasive pests. Research activities have accomplished breakthroughs in the areas of *Harrisia Cactus Mealybug* population monitoring, natural controls, breeding, life cycle descriptions, and alternate host breadth. During FY 2009 the AES allocated 10 FTE/SY to the Natural Resources and Environment program. About half of the projects were sponsored by non-formula funds.

The smallest programs in our research portfolio in terms of FTE and formula funds allocated continue to be the Agricultural Economics, Marketing, Value Added and Community Development (AEMCD) program, and the Food Safety, Science and Technology (FSST) program. Both programs are expected to play a more significant role in our institutional outlook in the future, when several affiliated faculty resources return from graduate-study leaves abroad.

In the AEMCD program, research was performed to determine consumer preferences, marketing margins, and farmers' and other participant's shares in the marketing channels of selected agricultural commodities. Work has also continued on the identification of issues of concern to land grant stakeholders, ranging from commodity-areas stakeholders, to other community groups focusing on alternative agriculture. In collaboration with Extension Faculty and Agents, results from projects were translated into recommendations for farmers and community organizers. Publications were prepared and presentations were made to producers' associations, agricultural professionals and college students majoring in agricultural sciences. Updated materials on new markets and marketing tools have been prepared in collaboration with extension agents, and farmers participating in sponsored activities have improved their knowledge on these topics, whereas students majoring in agricultural sciences have learned to use record keeping and accounting software. The total FTE/SY dedicated to this program in 2009 was 2.8.

The Food Safety, Science and Technology program mission is to promote the quality of life and economic viability of the agricultural sector by means of a continuous improvement process of current, and development of new, food and non-food products and their respective manufacturing and related processes. Still without a fully operative infrastructure, much effort was placed last year into acquiring and setting-up new equipment for the recently built facilities. In spite of delays in these processes, researchers have been able to continue working on their projects and supporting the local industry with training, focused research, analytical services and technical aid. Several industry collaborations have been already established. Results from the collaboration with a local brewery were implemented in their production process. A second collaboration agreement was signed with the state Department of Agriculture to offer a total of five courses to 25 local farmers, production nuclei and small value-adding entrepreneurs. During FY 2009 the AES allocated 1.7 FTE/SY to the FSST program.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	55.0	0.0
Actual	0.0	0.0	56.0	0.0

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

- Internal University Panel
- Combined External and 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 AES Research Office. Proposals are submitted to the Assistant Dean for Research with the preliminary endorsement of the respective Department Head. The Assistant Dean for Research sends the proposal again to the corresponding department head, to a local peer reviewer and to an external reviewer for their written comments on the scientific merit of the proposed research and compliance with the AES strategic plan. Proposals and their reviewers' input are discussed and evaluated by the CAS Associate and Assistant Deans for Research, and a final decision is taken by the administration. Project directors of the selected proposals are given the opportunity to incorporate reviewers' suggestions and make adjustments as appropriate. These proposals are then sent to the USDA-NIFA Office of the Administrator, where the respective national program leaders review them. Once the proposals are approved in Washington, the new or revised projects are included in the AES research program. In 2009, following this process, two new proposals were granted covering the research priorities of our programs in the areas of organic fertilization and revenue opportunities for the local coffee industry.

III. Stakeholder Input**1. Actions taken to seek stakeholder input that encouraged their participation**

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

Brief explanation.

Two types of meetings are held in Puerto Rico to identify critical issues that should be addressed by AES research programs. Stakeholder input is also considered during the establishment of research priorities. First, the AES 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 current process 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 AES Research Office during the year. The inputs received during the past three years from traditional and non-traditional stakeholders and from government officials, have been critical for starting a pilot organic experimental farm, and for guiding our research infrastructure development to better deal with the threats presented by invasive species.

Brief Explanation of what you learned from your Stakeholders

- The list of problems identified by our stakeholders as plaguing their operations is very long, but on closer analysis reveals that in many instances there are already technological alternatives available that have been

researched and could improve their situation, if they could be more actively disseminated among Extension personnel and farmers. This closer integration between research and extension needs to be coordinated at higher administrative levels. Last year, steps were taken by administrators in this direction, and a closer collaborative relationship is being established between research and extension faculty working in our Integrated Management of New and Emerging Pests program and Extension's Crop Protection program. Already this collaboration has been instrumental for quickly assembling an integrated research and extension team to prepare an emergency response to the recently detected citrus greening disease.

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

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	4088274	0

2. Totalled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	4002750	0
Actual Matching	0	0	4316554	0
Actual All Other	0	0	361858	0
Total Actual Expended	0	0	8681162	0

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

V. Planned Program Table of Content

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

V(A). Planned Program (Summary)**Program # 1****1. Name of the Planned Program**

Milk and Meat Production Systems

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			20%	
301	Reproductive Performance of Animals			10%	
302	Nutrient Utilization in Animals			25%	
303	Genetic Improvement of Animals			10%	
304	Animal Genome			5%	
306	Environmental Stress in Animals			5%	
307	Animal Management Systems			5%	
308	Improved Animal Products (Before Harvest)			10%	
313	Internal Parasites in Animals			5%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	11.2	0.0
Actual	0.0	0.0	10.0	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	2117228	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1829006	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	290635	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

The research topics that received the most attention during the year were:

1. Beef cattle feeding and management practices and their effects on growth and carcass characteristics
2. Use of genetic markers to assist selection of beef cattle for meat tenderness
3. Evaluation of the agronomic characteristics, chemical composition and feeding value for small ruminants of several leguminous forages and non-leguminous shrubs
4. Testing of both grain and forage-type sorghums.
5. Alternative sources of fertilizer nitrogen for use with grass forages
6. Control of internal parasites in small ruminants and dairy heifers by both traditional and alternative methods
7. Reproductive management practices in swine
8. Use of the industrial byproduct glycerol in diets for dairy cows
9. Diurnal body temperature patterns in dairy cows
10. Chemical properties of grasses as a guide to their suitability for ensiling
11. Subterranean irrigation of forages

Progress in the genetic improvement of the Senepol herd as witnessed by the sale of a group of animals to beef breeders in the Dominican Republic was a highlight of the year. Contacts with stakeholders of the beef industry were numerous and fruitful. The new milking parlor at the dairy unit of the Lajas Substation finally began operating in May and subsequently one feeding experiment with lactating cows was completed, with several others ready to begin in February, 2010. The small ruminant and forage research programs were very active and closely related, as many of the forages being evaluated underwent in vivo testing of voluntary consumption and digestibility in goats or sheep. A number of recent MS theses have been based on this type of research, and fortunately, corresponding papers for publication in scientific journals are also being submitted. One commercial forage producer planted 4 hectares of *stylosanthes* and produced hay of a quality comparable to that of imported alfalfa, for which he was paid the same price. The same farmer also planted 16 hectares of forage sorghum that was scheduled to be harvested for haylage production in February, 2010. Another forage producer adopted the use of alternative nitrogen sources (liquid urea and poultry litter) for fertilizing grass forages. A further success was the funding by the Commonwealth Department of Agriculture of an infrastructure project to assist farmers with pasture establishment. Although only the modest sum of \$50,000, was assigned for this purpose, in these times of very tight budgets it represents a hopeful sign. Contacts with stakeholders included fewer field days in 2009 than in previous years, which is a situation that should be corrected, as a major part of our strategy to convince producers to adopt RMP depends on demonstrating how these practices function in the field, either at institutional facilities or at producers' private farms. We must emphasize obtaining producer's opinions about RMP and the likelihood of their adoption as a key measure of outcomes.

2. Brief description of the target audience

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

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed**3. Publications (Standard General Output Measure)****Number of Peer Reviewed Publications**

2009	Extension	Research	Total
Plan	0	5	
Actual	0	7	7

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	Target	Actual
2009	5	5

Output #2**Output Measure**

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

Year	Target	Actual
2009	5	4

Output #3**Output Measure**

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

Year	Target	Actual
2009	5	4

Output #4**Output Measure**

- Number of publications made in refereed scientific journals.

Year	Target	Actual
2009	5	7

Output #5

Output Measure

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

Year	Target	Actual
2009	{No Data Entered}	20

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	30	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
306	Environmental Stress in Animals
308	Improved Animal Products (Before Harvest)
313	Internal Parasites in Animals

Outcome #2

1. Outcome Measures

% market participation of local beef.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	15	13

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Beef production in Puerto Rico has been declining in the last 25 years. There are many problems with the production and marketing structure of the local industry that are contributing to this situation. The low net return in cow-calf and cattle feeding operations is, however, one of the principal concerns. In addition, the industry has never established a quality grading system to offer consumers a product with a quality assurance. The void left between local consumption and local production is filled by imported graded and branded beef.

What has been done

To regain lost market participation producers need to add value to their beef by differentiating it from the imported product. To support farmers in this endeavor, research is emphasizing on the development of economic feeding systems that can decrease slaughtering age of grass-fed cattle, characterizing the chemical composition and nutritional value of local beef, and using genetic markers to assist selection of beef cattle for meat tenderness.

Results

Seminars, workshops and field days have been held with producers and extension personnel on beef cattle feeding and management practices and their effects on growth and carcass characteristics. In conjunction with the Agricultural Extension Service and producers associations, an educational campaign targeting consumers on the nutritional value of locally-produced beef was begun last year. We expect that the establishment of a quality grading system would help organize the market, increase beef cattle prices, and build up consumer confidence and demand for the local product.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
307	Animal Management Systems
308	Improved Animal Products (Before Harvest)

V(H). Planned Program (External Factors)**External factors which affected outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Other (Delays in new facilities construction; deterioration of research facilities and equipment)

Brief Explanation

By the end of 2009 the new milking parlor was fully functional, except for the need to move a second tank from the old milk room and install it in the new facilities, thus to accommodate the anticipated volume of production in the near future. Several other details of the physical facilities need attention to promote animal well-being and convenient movement of groups of animals. Given the present large herd size, the pasture land must be used efficiently, which requires putting all the fences in good order, controlling weeds, applying fertilizer and irrigation during periods of little rainfall, and maintaining a well-organized rotational grazing routine. Progress in these particulars has been slow. Finally, the uncertainty as to how severe and for how long the current financial crisis of the University of Puerto Rico (and of the country in general) will be, is a major impediment to realistic planning and orientation of a research program to optimize the use of limited resources in support of endeavors that will result in the most

beneficial effects when applied on producers farms.

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

1. Evaluation Studies Planned

- Before-After (before and after program)
- null

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 2****1. Name of the Planned Program**

Integrated Management of New and Emerging Pests

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
211	Insects, Mites, and Other Arthropods Affecting Plants			25%	
212	Pathogens and Nematodes Affecting Plants			32%	
213	Weeds Affecting Plants			5%	
215	Biological Control of Pests Affecting Plants			26%	
216	Integrated Pest Management Systems			12%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	13.1	0.0
Actual	0.0	0.0	14.1	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	609821	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	661477	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	14718	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

During this year significant accomplishments in pest and disease characterization have been reached. The implementation of molecular diagnostics led to the identification of *Candidatus liberibacter asiaticus*, *Clavibacter michiganensis* subsp. *michiganensis* and of new mites and thrips species in Puerto Rico. A collaborative effort with the Extension Service was initiated to determine the spread of citrus greening and a working group was organized to prepare an emergency response. A survey conducted in collaboration with Extension and APHIS/PPQ determined that the disease was spread to commercial orchards.

Workshops were conducted in several municipalities to raise awareness of existing practices that may affect disease outbreaks, to enhance prevention measures to decrease the spread of the disease, and to stress the importance of using disease-free plants. The Diagnostic Clinic received a record of approximately 800 samples for pest and disease identification.

In addition, invasive species have received special attention with several initiatives: (1) to develop island-wide host vegetation maps (including crops and natural vegetation) and to correlate with predicted distributions of potentially invasive arthropods, and (2) to assess the relative risk which different ports of entry pose, based on interceptions and successful colonization by invasive species in the past. Studies in new invasive species have included *Raoiella indica*, to determine which species of native generalist predators reproduce, feed, and survive on a *R. indica* diet. We have also conducted several surveys to determine the current infestation levels of the Chili thrips on the island, including ornamentals in nurseries.

In collaboration with the Extension Service more than a hundred farmers have received research-based information about the integrated management of Black Sigatoka with selected appropriate fungicides for improved control. Educational materials published included two field guides in identification and management of Black Sigatoka and two papers with research results.

2. Brief description of the target audience

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

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	960	480	50	100

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	3	
Actual	3	9	12

V(F). State Defined Outputs

Output Target

Output #1**Output Measure**

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

Year	Target	Actual
2009	1	1

Output #2**Output Measure**

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

Year	Target	Actual
2009	3	4

Output #3**Output Measure**

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

Year	Target	Actual
2009	10	5

Output #4**Output Measure**

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

Year	Target	Actual
2009	9	15

Output #5**Output Measure**

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

Year	Target	Actual
2009	9	14

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	Target	Actual
2009	3	3

Output #7**Output Measure**

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

Year	Target	Actual
2009	4	5

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
2	Number of persons that 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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	100	100

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Efforts have been concentrated on developing and extending alternatives to the production constraints associated to emerging pests and diseases of major crops in Puerto Rico

What has been done

Plantains and bananas are the most economically important crops of Puerto Rico at present. Black Sigatoka (BS) represents the most serious threat for the production of bananas and plantains in the island because local production relies on highly susceptible germplasm. While efforts are underway to identify and evaluate resistant varieties, alternatives to manage the disease are also being devised. Research has already established the incidence and severity of BS at two localities in Puerto Rico and the effectiveness of systemic and contact fungicides for the control of BS on bananas is under study. Preliminary results have been instrumental for testing a spraying program for the control of the disease based on local weather conditions and available chemistries.

Results

More than 100 farmers received information about the integrated management of BS with selected appropriate fungicides for improved control. During the Plantains National Festival more than 400 farmers visited banana and plantain fields at the Corozal Substation. They acquired knowledge about the growth and development of bananas and plantains, and observed the management practices available to control pests and diseases. Educational materials published included two field guides in identification and management of BS and two papers based on research results. In citrus, four workshops were conducted in several municipalities to raise awareness of existing practices that may affect Citrus Greening disease outbreaks.

4. Associated Knowledge Areas

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

Outcome #2**1. Outcome Measures**

Number of persons that adopted reduced risk pesticides and practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	25	25

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Before the implementation of this program, chemical companies' recommendations regarding pest and disease control had a major influence on farmer's decisions to spray. In the past three years the AES IPM program has increased research and outreach activities in the utilization of ecologically-based integrated pest management. The program also integrated and coordinated existing research and extension activities to enhance prevention, preparedness, response, and recovery efforts regarding new diseases. We still lack, however, a precise method of assessing adoption of recommended practices.

What has been done

Current activities focus in the use of barrier crops as a cultural method to control non-persistent viruses in watermelon. More than 100 virus isolates from cucurbit plants in Puerto Rico have been obtained. Many of these isolates have been characterized (biologically and by bimolecular means) and used in the selection of resistant pumpkin lines. The virus strains are now part of a new virus collection established at the Rio Piedras Experiment Station. Two graduate students are working with the selection of superior plant genotypes with resistance to Papaya Ringspot Virus (PRSV) and Zucchini Yellow Mosaic Virus (ZYMV).

Results

The number of watermelon growers that use reduced-risk insecticides to control watermelon vine decline has increased. Even though the disease still causes severe losses, as a result of the outreach activities growers have implemented crop rotation and crop diversification in the main production area.

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems

Outcome #3**1. Outcome Measures**

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	25	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Farmers' knowledge and perceptions of pests and diseases in Puerto Rico have changed. The availability of disease and pest diagnostics through the Plant Disease Clinic (Southern Plant Diagnostic Network) provides an early and accurate diagnosis of pathogens essential for preventing disease outbreaks.

What has been done

Over 4,000 determinations have been conducted at the Disease Clinic in Juana Diaz. The Network with the University of Florida Disease Clinic has maximized accurate identification and expanded the impact of the Clinic to the Caribbean Region. Three exotic pests and two new diseases have been identified and mitigation measures have been implemented.

Results

The reduction of losses due to emerging diseases is difficult to document at this stage. However, the analysis of diseases of quarantine significance in 8 different crops provides a framework for emergency response in case of new disease introductions, therefore decreasing the risks of losses due to new diseases.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Appropriations changes
- Other (Inability to gauge progress in technology adoption)

Brief Explanation

The south coast of Puerto Rico, a major agricultural production region, has been affected by severe droughts during the recent past. We lack information on how this factor has affected output or farm management decisions by operators of the area. Budget cuts at the university limits our capacity to recruit much needed technical support to expand our work and outreach activities, at a time when new pests and diseases are being detected at a faster pace than before. While closer collaboration with Extension has helped in this respect, we still lack a reliable mechanism to assess if program-based research is being adopted.

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

1. Evaluation Studies Planned

- During (during program)
- Other (Yearly baseline indicators)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)**Program # 3****1. Name of the Planned Program**

Plant genetic resources, breeding and production systems

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			20%	
202	Plant Genetic Resources			20%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			25%	
204	Plant Product Quality and Utility (Preharvest)			5%	
205	Plant Management Systems			30%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	18.5	0.0
Actual	0.0	0.0	17.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	985508	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	1394750	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	18948	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Two formal meetings were held to review activities within this program; attendees included representatives of the academic departments and the commodity group leaders.

We continued to experience notable progress in hosting activities for stakeholders at the stations facilities and in other

experimental fields. A forum on the situation of organic farming and perspectives attracted over 200 stakeholders. Attendees to field days and associated activities totaled 579 stakeholders.

On-farm research to validate technologies was maintained during last year. With the collaboration of the Extension Service, the tropical-type sweet potato variety 'Pujols' was evaluated by 20 farmers in eight municipalities.

Work continued on the selection and purification of germplasm of traditional crops, on the development of improved cultivars, and on the distribution of germplasm to farmers, scientists and to the public. Variety 'Badillo', a light red kidney bean which is resistant to multiple diseases, was released for commercial use.

During this past year, seeds of improved varieties of sweet chili pepper, papaya, eggplant, bean, pigeon pea, field corn, sweet corn, black-eyed pea, tropical pumpkin, tropical-type sweet potato, tanager, banana, plantain, cassava, and taro were sold at the field stations, thus indicating farmers' continued support and acceptance of the output of this research program. The AES began distributing to farmers and other interested stakeholders limited amounts of seed grown under organic crop management. The latter seed were for sweet chili pepper, tropical pumpkin, cucumber, black-eyed pea, and tropical-type sweet potato.

More than fifty presentations were delivered at scientific meetings by program researchers and by graduate students associated with this program. Ten graduate students finished their masters degree by performing research work related to this area. Nine other students were participating within the program.

Twenty-one articles authored by academic personnel and by graduate students were published in refereed journals and five non-refereed articles were included in proceedings. More than 1,800 hard copies of technological packages on the different crops were distributed during the year.

A web site to exchange technical information on organic agriculture in Puerto Rico, with special emphasis on vegetable production and vegetable-seed production, was developed. An additional web site for the vegetable breeding program and a Blog for turf management were maintained. Electronic pages dealing with research activities under this program received over 2000 hits.

Noteworthy progress was made on attracting complementary external funds for activities related to this planned program. Last year program-related personnel obtained over two hundred thousand dollars in seven competitively funded projects.

2. Brief description of the target audience

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

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	2	
Actual	0	21	21

V(F). State Defined Outputs**Output Target****Output #1****Output Measure**

- Number of stakeholders to adopt the proposed BMPs.

Year	Target	Actual
2009	115	115

Output #2**Output Measure**

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

Year	Target	Actual
2009	1	0

Output #3**Output Measure**

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

Year	Target	Actual
2009	1500	2000

Output #4**Output Measure**

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

Year	Target	Actual
2009	240	240

Output #5**Output Measure**

- Number of participants in the field days coordinated with Extension

Year	Target	Actual
2009	125	579

Output #6**Output Measure**

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

Year	Target	Actual
2009	125	19

Output #7**Output Measure**

- Number of refereed publications

Year	Target	Actual
2009	2	21

Output #8**Output Measure**

- Number of non-refereed publications

Year	Target	Actual
2009	2	5

Output #9**Output Measure**

- Number of presentations in scientific meetings

Year	Target	Actual
2009	2	54

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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

Outcome #1**1. Outcome Measures**

Number of stakeholders to adopt the proposed BMPs

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	115	115

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Puerto Rico's population has a high dependence on imported food. Local agricultural products compete against those imported from countries where production costs are lower. To maintain their competitiveness, local farmers have shown interest on mechanisms to improve the profitability of crop production and commodity marketing. To achieve sustainable farming systems, however, profitable BMPs for crop production must be devised that simultaneously protect natural resources.

What has been done

Work has continued on the selection and purification of germplasm of traditional crops, on the development of improved cultivars, and on the distribution of germplasm to farmers, to scientists and to the general public. BMPs for local crops and farming systems are being reevaluated and alternatives are being sought for maintaining production levels and profitability. On-farm research to validate newly developed technologies also continued during last year.

Results

The AES seed program offered for sale seeds and setts of improved varieties adapted to local conditions of more than fifteen food crops. More than 1,800 copies of technological packages and bulletins describing BMPs for local crops were distributed during the year. The number of stakeholders, especially farmers, attending activities such as field days and workshops continued to increase over the previous year. Since these activities are held to show the new technology developed under the program, we believe that the increase in attendance is an indicator of the willingness of producers to incorporate at least part of the demonstrated technologies into their farm operations.

4. Associated Knowledge Areas

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

Outcome #2**1. Outcome Measures**

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	100	100

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Farmers frequently point out that the lack of high quality seed and propagation material limits the production and acreage expansion of traditional crops. Farmers in Puerto Rico are typically smallholders, and commercial seed companies do not always maintain an inventory of the seeds or propagation materials used by these producers.

What has been done

The AES seed program offered for sale seeds and setts of varieties adapted to local conditions and management systems. For some crops, the AES is the only reliable source of seed. Citrus and mango germplasm collections were also used to provide selected material for the commercial propagation of these fruits.

Results

The sale of seeds and setts of improved varieties remained strong during 2009. We believe this is an indicator of farmers continued support and adoption of outputs of the AES research program.

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**

- Economy
- Appropriations changes
- Other (Lack of precise evaluation mechanisms)

Brief Explanation

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. We still lack a reliable mechanism to asses the impact of program-based research.

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

1. Evaluation Studies Planned

- During (during program)

Evaluation Results

Key Items of Evaluation

V(A). Planned Program (Summary)**Program # 4****1. Name of the Planned Program**

Natural Resources and Environment

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			5%	
104	Protect Soil from Harmful Effects of Natural Elements			7%	
111	Conservation and Efficient Use of Water			7%	
112	Watershed Protection and Management			23%	
123	Management and Sustainability of Forest Resources			10%	
133	Pollution Prevention and Mitigation			38%	
136	Conservation of Biological Diversity			10%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	9.0	0.0
Actual	0.0	0.0	9.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	212178	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	360360	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	27800	0

V(D). Planned Program (Activity)**1. Brief description of the Activity**

During last year several research activities conducted under this program were finished and results were submitted for publication and disseminated to our targeted audiences through meetings, field days, a seminar series, and other means. In

avocado production, data acquired on irrigation scheduling during a 5-year period indicated that avocado trees responded better to microirrigation when soil water tension was about 40-45 kPa in comparison with field capacity and rainfed treatments.

On the area of water quality and ecosystem integrity important preliminary results of one of our projects suggest that the status of our reservoirs, currently listed as impaired because of a violation of the dissolved oxygen (DO) aquatic life criteria, may be based on a flawed understanding of the mechanisms controlling DO dynamics in tropical reservoirs. Runoff associated with intense rainfall is probably the major contributor of hypolimnion-dissolved oxygen and nutrient recharge at one of the reservoirs studied. In the absence of such events, hypolimnion anoxia develops quickly (two weeks) and follows a pattern largely controlled by thermal stratification. The initial results of this project tend to support the research team hypothesis that hypolimnion anoxia in Puerto Rico is largely a temperature-controlled phenomenon and cannot be used as an index of trophic status or reservoir impairment. Recently, researchers were able to link a significant fish kill event at La Plata reservoir to the effect of anoxia. Government agencies have become more aware of the impact of hypolimnion anoxia and are considering investing, at least on a trial basis, in some type of oxygenation/aeration system to evaluate its effect on water quality and fish habitat restoration. Results from this project are critical for guiding this important decision-making process.

Important progress has also been made towards devising a solution to the environmental problem caused by coffee hull disposal. Researchers have been able to develop a high quality, stable compost produced from coffee hull, useful for plant propagation and general ornamental and gardening use. The compost has been made available to nearby communities of the Adjuntas Experimental Substation, in the coffee region, and demand already equals or exceeds the current capacity of the production plant.

Significant achievements have been made regarding the protection of our dry forest cacti from invasive pests. The *Harrisia Cactus Mealybug* (HCM) has been found attacking most columnar cactus species in Puerto Rico. Research activities have accomplished breakthroughs in the areas of HCM population monitoring, natural controls, breeding, life cycle descriptions, and alternate host breadth. Identification of a variety of natural control agents provides informational and biological baselines for classical biological control options for future infestations elsewhere, or for possible exotic introductions in Puerto Rico. Activities within the project have also demonstrated the feasibility of using *Alternanthera* plants as hosts for mass rearing operations.

2. Brief description of the target audience

Extension Specialists and professionals, government partners, producers, consumers, and environmental groups.

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009
 Plan: 0
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
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Plan	5	0	
Actual	0	5	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Target	Actual
2009	15	15

Output #2

Output Measure

- Number of Peer Reviewed publications.

Year	Target	Actual
2009	5	5

Output #3

Output Measure

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

Year	Target	Actual
2009	2	2

Output #4

Output Measure

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

Year	Target	Actual
2009	2	4

Output #5

Output Measure

- Number of book publications.
Not reporting on this Output for this Annual Report

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 conservation and management, microirrigation scheduling, and other soil enhancement and water conservation practices
2	Number of farmers adopting microirrigation management practices
3	Number of persons adopting practices that prevent biodiversity threats and losses
4	Number of farmers adopting methods to increase soil organic matter content
5	Number of farmers reporting increased water use efficiency in their farms
6	Number of persons that adopted practices to improve water resources.
7	Number of watersheds for which a Total Maximum Daily Load (TMDL) for nutrients have been developed

Outcome #1**1. Outcome Measures**

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	75	75

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Water for farming is increasingly an island-wide issue as other sectors put forward competing demands for this resource. The issue is particularly acute in the south coast, where most of the large commercial fruit and vegetable operations are located. Farmers, extensionists, government officials and the general public need to have access to better information tools on water conservation and management.

What has been done

Evaluation of irrigation levels and frequencies based on evapotranspiration (ET) calculation for different crops; workshops, field days, meetings and seminars on research results on the above topics; publication of results in proceedings of professional associations and in refereed journals.

Results

In the case of onion, evaluation of irrigation levels and frequencies based on ET calculation confirm that the potential to increase production and commercial onion yield can be achieved by the implementation of management practices that prevent stress conditions during growth. Better results were obtained by increasing the level and frequency of irrigation using the Pan Evaporation method under the arid conditions of southern Puerto Rico. These results will contribute to higher productivity, better quality, and improved economic returns for the farmers of this region.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Number of farmers adopting microirrigation management practices

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	20	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water

Outcome #3

1. Outcome Measures

Number of persons adopting practices that prevent biodiversity threats and losses

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	40	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The alarming rate of introduction of invasive species in Puerto Rico and the recurrent damage of hurricanes and forest fires in our reserves are conceived as major threats to our ecosystem. Stakeholders concerned with these issues include personnel from the Departments of Agriculture and Natural Resources, the Dry Forest Coalition, government officials, extensionists and the general public who travels and visit forest reserves

What has been done

Undergraduate and graduate students have been trained in forest and invasive species management. Several seminars and workshops have been presented to broad audiences about these topics. Project directors are active participants in task forces created to address the threats posed by several particularly damaging invasive species.

Results

Research activities have accomplished breakthroughs in the areas of *Harrisia Cactus Mealybug* population monitoring, natural controls, breeding, life cycle descriptions, and alternate host breadth. Identification of a variety of natural control agents provides informational and biological baselines for classical biological control options for future infestations elsewhere, or for possible exotic introductions in Puerto Rico.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Number of farmers adopting methods to increase soil organic matter content

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	40	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
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements

Outcome #5

1. Outcome Measures

Number of farmers reporting increased water use efficiency in their farms

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	60	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The adoption of technologies that can potentially improve water conservation and crop yield is particularly important in the arid south coast, where most of the large commercial fruit and vegetable operations are located. Irrigation is a resource with a high energy demand; maximization of crop water use efficiency is essential. This indicator is closely related to the one on the adoption of microirrigation management practices.

What has been done

Several trainings, workshops and seminars have been given to extensionists and farmers to promote water conservation through watershed protection, irrigation techniques, and drip irrigation management.

Results

Several farmers have adopted the watershed conservation practices and microirrigation techniques, presumably reducing the contamination of the aquifers, production costs, and fertilizer losses, but more precise data based on a survey of farmers' on farm results is still lacking.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Number of persons that adopted practices to improve water resources.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

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

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Appropriations changes
- Other (lack of reliable evaluation mechanisms)

Brief Explanation

As is the case with most of our planned programs, some of our original measures were underestimated, others were overestimated, and for others no estimation was available. We still lack a reliable mechanism to assess the impact of program-based research, and with current budget cuts it is unlikely that an independent evaluation component will be added to more precisely measure the impact of our programs.

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

1. Evaluation Studies Planned

- Other (Undecided yet)

Evaluation Results

Key Items of Evaluation

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			32%	
606	International Trade and Development			5%	
607	Consumer Economics			15%	
608	Community Resource Planning and Development			10%	
610	Domestic Policy Analysis			5%	
	Total			100%	

V(C). Planned Program (Inputs)**1. Actual amount of professional FTE/SYs expended this Program**

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.4	0.0
Actual	0.0	0.0	2.8	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	77789	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	70765	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. A survey of the meat stand owners in municipal markets was conducted. Aggregated results from this and previous surveys of plantain consumers provided valuable data to policy makers and merchants related to consumer preferences, marketing strategies and possible new food products. Work has also continued on the identification of issues of concern to land

grant stakeholders, ranging from traditional commodity-areas stakeholders, to other community groups focusing on alternative agriculture. A forum on organic agriculture in Puerto Rico was held and information on the research and education needs of the audience was collected and analyzed. In collaboration with Extension Faculty and Agents, results from projects were translated into recommendations for farmers and community organizers. Publications were prepared and presentations were made to producers' associations, agricultural professionals and college students majoring in agricultural sciences.

2. Brief description of the target audience

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

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009
 Plan: 0
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	2	
Actual	0	2	2

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of refereed publications

Year	Target	Actual
2009	2	2

Output #2

Output Measure

- Number of presentations in scientific meetings

Year	Target	Actual
2009	3	3

Output #3

Output Measure

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

Year	Target	Actual
2009	3	4

Output #4

Output Measure

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

Year	Target	Actual
2009	70	530

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of stakeholders gaining knowledge about new markets and marketing tools
2	Number of alternative marketing projects identified as existing in Puerto Rico (long-term)

Outcome #1**1. Outcome Measures**

Number of stakeholders gaining knowledge about new markets and marketing tools

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	80	530

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

As globalization continues to restructure local wholesale and retail distribution outlets, remaining farmers increasingly complain about fewer markets for their crops. Puerto Rico needs to increase the competitiveness of its traditional agriculture and find new opportunities and niches in which it could be competitive. Research on new markets and marketing tools is relevant to farmers seeking for new knowledge, extension agents that need to transfer knowledge to farmers, and college students majoring in the agricultural sciences.

What has been done

Workshops with extension agents; seminars attended by farmers and other stakeholders; presentations at local farmer fairs; laboratories and video tutorials tested with college students.

Results

Among other impacts, extension agents are assisting farmers with updated material on these topics; farmers participating in sponsored activities have improved their knowledge of markets and marketing tools, and college students majoring in agricultural science have learned to use record keeping and accounting software.

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 alternative marketing projects identified as existing in Puerto Rico (long-term)

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Other (Termination of projects)

Brief Explanation

For the last five years we had a project researching the opportunities and constraints faced by emerging farmers' markets in the island. This project terminated in 2008, and although research and education on improved marketing tools continues to be a priority of the program, we thought that given the prevailing economic conditions in Puerto Rico, the creation of new alternative marketing projects might not be a reasonable measure of the Program's outcomes. During this year another indicator was devised to better portray the progress achieved in meeting the Program's objectives.

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

1. Evaluation Studies Planned

- Other (Focus group)

Evaluation Results

Key Items of Evaluation

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			10%	
502	New and Improved Food Products			28%	
503	Quality Maintenance in Storing and Marketing Food Products			41%	
504	Home and Commercial Food Service			14%	
701	Nutrient Composition of Food			5%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			2%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of professional FTE/SYs expended this Program

Year: 2009	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.8	0.0
Actual	0.0	0.0	1.7	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	226	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	196	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	9757	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

As expected, a lot of effort was placed into setting up the recently built facilities. During 2009, we acquired about \$1M worth

of equipment for the teaching and research facilities. Arrival of some of the equipment is still pending; the installation process should be completed during the first half of 2010. Also, the hiring process was initiated to fill the vacant researcher position (75% research/25% teaching) at the Experiment Station. In spite of these delays, researchers continue working on their projects and supporting the local industry with training, focused research, analytical services and technical aid.

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

V(E). Planned Program (Outputs)

1. Standard output measures

2009	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Plan	0	0	0	0
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2009

Plan: 0

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2009	Extension	Research	Total
Plan	0	1	
Actual	0	3	3

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	Target	Actual
2009	1	10

Output #2

Output Measure

- Number of projects or industry collaboration agreements established

Year	Target	Actual
2009	1	2

Output #3

Output Measure

- Funds awarded to the program from research and training grants

Year	Target	Actual
2009	{No Data Entered}	89400

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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

Outcome #1**1. Outcome Measures**

Total Number of Enterprises Impacted by the Program

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	25	40

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

Research should not be detached from the food industry. The interaction keeps faculty aware of industry needs and thus updated, focused and better positioned to prepare students to address such needs. These collaboration projects not only fulfill such intent, but also often allow for students to enter the industry world and obtain first-hand experiences.

What has been done

There are three types of industry collaborations: training, projects and services. We offer various training courses on topics such as GMP/GAP, HACCP, BPCS, and food defense. Projects refer to larger product or process development efforts that last for several months. Services refer to microbiological, chemical or nutritional analysis performed at industry's request on a given product sample. The metric includes all types.

Results

During 2009-10, the collaboration project with the local brewery continued. Results from the study were presented to the customers and implemented in the production process. We are in the process of setting up a second collaborative project with the same company. A second collaboration agreement was signed with the state Department of Agriculture to offer a total of five courses to 25 local farmers, production nuclei and small value-adding entrepreneurs. Aside from this agreement, we offered several other courses open to the public. Finally, a total of 9 service collaboration requests were addressed.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
701	Nutrient Composition of Food
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #2**1. Outcome Measures**

Food Manufacturing Exports in million dollars

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	4333	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

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

What has been done

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

Results

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

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
701	Nutrient Composition of Food
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #3**1. Outcome Measures**

Food Manufacturing Imports in million dollars

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Quantitative Target	Actual
2009	2831	0

3c. Qualitative Outcome or Impact Statement**Issue (Who cares and Why)**

The program strives to influence the local food industry. With population growth and a decline in farmland and agricultural related employment, imports increase year after year. By continually interacting with industry, the program strives to shift the market from importing goods to producing them.

What has been done

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

Results

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

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
701	Nutrient Composition of Food
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Competing Programmatic Challenges

Brief Explanation

Economy &ndash 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. Also, program activities during the second half of 2009 were affected by strikes and other situations that periodically disrupted the access to university facilities and broke the continuity of effort.

Competing programmatic challenges &ndash Collaborating faculty is not solely dedicated to this program. Instead, they belong to other departments and they need to address issues as their respective departmental programs so require. Thus, we have a pool of researchers who are constantly entering and leaving, depending on their projects' cycles.

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

1. Evaluation Studies Planned

Evaluation Results

Key Items of Evaluation