2014 University of Puerto Rico Research Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The mission of the University of Puerto Rico Agricultural Experiment Station (PRAEXS) 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 industries that process agricultural raw materials, and provides the technological base required for solving problems affecting farmers, farming operations, public and private institutions, and rural development. The PRAEXS coordinates its academic activities with the teaching faculty of Agricultural Sciences and the Agricultural Extension Service, and incorporates into its research program the faculty of these two institutional units of the CAS. During the Plan of Work (POW) cycle covering this annual report, the PRAEXS and the Puerto Rico Agricultural Extension Service (PRAES) filed separate submissions; last year we prepared a combined Research and Extension POW for 2015. This 2014 annual report will therefore be the last in which the PRAEXS will report its accomplishments and results separately.

The PRAEXS 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 PRAEXS 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 the evaluation of crop and animal production systems adapted to different ecological zones.

Core funding for the PRAEXS'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 financing the research program directly and supplementing salaries of faculty and staff. Formula-funds include Hatch Regular, Hatch Regional, McIntire-Stennis and Animal Health; however, in this annual report we only include under planned program reports FTEs funded by Hatch and Hatch Multistate. Nonetheless, activities and results reported include all of our efforts, a significant proportion of which are funded by external sources and performed with the volunteer efforts of our staff. For FY2014, the Hatch allocation for Puerto Rico was $4,526,160. Along with state matching funds, other program income, and carry-over funds, the actual dollar amount spent on our planned programs in FY2014 was $6,478,610.

Last year PRAEXS continued to direct its research programs toward solving the most pressing problems identified by our stakeholders and faculty. Sixteen new projects, including six Hatch funded ones, were begun to address concerns related to a wide array of agrofood and natural resources problems.

In the **Milk and Meat Production Systems** program research continued supporting local dairy industry and beef cattle production including topics in nutrition, heat stress, mastitis, raw milk quality, farm management, forage research, testing of selected grass-fed crossbred heifers for growth performance and carcass and meat characteristics; study of genes associated with the slick hair trait in Senepol and Holstein cattle; and comparison of varying lengths of postmortem aging on meat tenderness. Extension

and Research efforts to educate producers about topics relevant to their operations, using a variety of methods of communication, were very active during the year. A number of field day and training sessions were well attended. Consulting services were provided for the benefit of both government officials and private sector parties. Program evaluation findings indicated that research on dairy cows crossbreeding to provide better breeds tolerant to heat stress is promising and should be continued. Satisfactory progress of the program is also observable from the willingness of some producers to have research under UPRM auspices carried out at their private farms. During 2014 PRAEXS allocated 4.2 FTE/SY and 26% of our Hatch funds to this program.

Work in the **Integrated Management of New and Emerging Pests and Diseases** (IMNEP) program continued during 2014 with commodity-driven priorities in the areas of pesticide registration, testing of "reduced-risk" pesticides, and validation and development of integrated management practices. Horticultural oil and imidacloprid were shown to be compatible with the release of natural enemies to control H. pungens, offering a selectivity effect to a wasp L. hypogeococci and a coccinellid predator, S. flavifrons. A series of alternative practices was disseminated to banana and plantain growers and extension educators for nematode control. Results will contribute to increasing the cost-benefit ratio of nematode control and decreasing the risks to human health and the environment associated with the use of chemical nematicides. Integrated management recommendations for the control of the coffee berry borer (CBB) were also validated and disseminated to agronomists and farmers in professional and community meetings. Approximately 200 stakeholders received recommendations about the management of new and emergent diseases in 16 different agricultural crops. In addition, the citrus orchards of Adjuntas and the "Citrus Germplasm Bank" of Isabela substations were evaluated for graft-transmissible diseases. Parent trees that were positive for Citrus Greening and Citrus Tristeza Visus were eliminated and healthy trees were covered with insect-proof screen. This program will distribute clean citrus material to growers. Twenty-six percent of our Hatch funds were dedicated to the IMNEP program during 2014.

The **Plant Genetic Resources, Breeding and Production Systems** (PGRBPS) program is at the core of PRAES efforts to improve food security in Puerto Rico and other tropical regions of the world. Work continued last year on the acquisition, evaluation, conservation and distribution of plant germplasm. New 'ají dulce' (Capsicum chinense) lines were developed and released. The introduction and evaluation of different crops, such as orange-fleshed sweet potato clones, also continued. In vitro propagation protocols, and fertilization and irrigation studies are being conducted for achachairú, a new niche market, high-value fruit crop. In citrus, germplasm collections maintained in screened houses at Isabela and Río Piedras were tested for Citrus Greening, Citrus Tristeza Virus, and Phytophthora. This germplasm is available for citrus producers. The land area planted with improved varieties increased over the past few years. At the substations, sales of pigeon pea, beans, Spanish squash and corn seeds, as well as planting material of taniers and plantains grew during last year. Puerto Rico Department of Agriculture (PRDA) statistics also reflect increases in the production of bananas, sweet potatoes, yams, taro, celeriac, and cassava between the 2013 and 2014 seasons. Research results on starchy crops, together with outreach by extension specialists and agents is believed to be behind these recent production increases. In 2014, the PGRBPS program engaged 8.5 FTE/SY and received 30% of our Hatch funds.

The main goal of the **Climate Change: Natural Resources and Environment** research program continues to be to develop, perform and support scientific research regarding the impact of agricultural practices on the environment and natural resources of Puerto Rico. The program addresses key Agricultural Experiment Station mission goals by supporting both the Department of Agriculture and the Natural Resources Department. During 2014, program activities continued with their focus on: measuring the impact of agricultural operations in the environment; developing pollution prevention and mitigation practices and thresholds for the protection of watershed and soil resources; developing soil improvement and maintenance practices; developing and promoting sustainable agricultural practices; determining the pathways of entry and ecological impact of non-native species; and developing management approaches

for conserving and restoring biodiversity. Several already mature projects reported results on their contribution to changing problematic conditions, particularly those related to the water quality of the island's watersheds and reservoirs. In April 2014, the PR Environmental Quality Board proposed an amendment of the prevailing nutrient standards in rivers of PR partially based on results obtained in one of our Hatch projects. The research conducted validated numeric nutrient criteria estimates developed in a previous study using a biological index component. PRAEXS allocated to this program 3.4 FTE/SY and 16% of its Hatch funds in 2014.

In the **Agricultural Economics, Marketing and Community Development** program research was undertaken to identify new market niches and promising new products, as well as to determine farmers' costs of production, consumer preferences, marketing margins, and farmers' and other participants' shares in the marketing channels of select agricultural commodities. Research was also undertaken to improve natural resource use by farmers and to support the policy-making process by government officials in order to achieve greater economic and material sustainability. Researchers in this program identified a highly profitable new market niche for Puerto Rico's farmers and have taken the lead in convincing a group of farmers to try producing the crop. The program evaluation performed during 2014 centered on gaining input for improving the possibilities of success for this initiative. A focus group of producers of the new crop emphasized the need to make young entrepreneurs the priority of the initiative, preferably those with a college degree, since they would be more inclined to try new products and favorably respond to a research-backed program than would older farmers. This program is still the smallest of our Hatch funded efforts, although FTEs increased last year, with only 0.6 FTE/SY and receiving less than 1% of the total allocation.

During 2014 the **Food Safety, Science, Technology and Childhood Obesity** program offered nine seminars on the Food Safety Program. Almost twenty food industry employees were trained in food safety and related topics (HACCP and SQF). Trainings were provided to nearly 140 farmers that produce lettuce for the School Lunch Program and for farmers in the Fresh Market Program of the Puerto Rico Department of Agriculture. The trainings focused on GAP and GMP. In an effort to help the food industry to improve and develop new food, we collaborated with 26 industries that contacted us. This collaboration with industry included chemical and/or microbiological analysis of food, nutritional fact analysis, and physicochemical properties of food. The FTE/SY devoted to this program in 2014 was 1.0; funds allocated amounted to 1.2% of Hatch funds. No Childhood Obesity activity was performed or proposed last year.

The **Sustainable Energy** program was created in 2011 in response to NIFA's request to include a Sustainable Energy goal among our local programs. Although no Hatch-funded project has been approved since its inception, we have opted to keep it in our POW with the expectation that formula funded projects in this area can be initiated in the future. High energy cost is one of the most important factors contributing to the rise in production costs and affecting the competitive position of agroindustry in Puerto Rico and we believe that research efforts initiated with external funding should continue to address this critical constraint. The two remaining research projects active in this program, however, were completed during 2014. One of the projects proposed and established a solar energy photovoltaic system at one of PRAEXS substations to both reduce the high cost of electricity at its facilities, and to serve as a model for potential adopters of this technology. The other project concluded a case study of the technical and economical aspects involved in implementing solar energy systems in milking parlors. The current integration of research and extension in our combined Plan of Work may facilitate the implementation of new initiatives in sustainable energy, but in the near future, only extension faculty will be conducting work in this program.

The total FTE/SY effort devoted to our programs last year and reported in this annual report is 63.3. This figure includes a significant amount of volunteer effort donated by our faculty to reach our goals. Depending on the base figure used (with or without volunteer efforts) Hatch funding supported between 37% and 40% of our scientists FTEs in 2014, providing an important leverage for attracting much

needed additional funding to our programs. Within our continuing budget constraints an effort was made to distribute funds to support initiatives in need of being strengthened, such as crop protection studies, and improving the research infrastructure serving our IMNEP, Natural Resources and Environment, and Breeding and Production Systems programs. Partnering with government departments that shared our goals and pooling our resources in support of mutual priorities, has enabled us to extend the impact of our work in these trying times.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	64.5	0.0
Actual	0.0	0.0	63.3	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 was no significant change in our merit review process since our last year update was submitted. We continued to allocate part of our Hatch-funded research to competitive project grants selected on the basis of an annual call for proposals with the year's revised priorities. More specifically, the scientific peer review process of Hatch proposals was the following:

A call for proposals including the year's revised research priorities was prepared and distributed by the PRAEXS Research Office. Proposals were submitted to the Assistant Dean for Research with the preliminary endorsement of the respective Department Head. The Assistant Dean for Research sent the proposals 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 PRAEXS strategic plan. Proposals and their reviewers' input were discussed and evaluated by the CAS Associate and Assistant Deans for Research, and a final decision was taken by the administration. Project directors of the selected proposals were given the opportunity to incorporate reviewers' suggestions and make adjustments as appropriate. These proposals were then sent to the USDA-NIFA Office of the Administrator, where the respective national program leaders reviewed them. Once the proposals were approved in Washington, the new or revised projects were included in the PRAEXS 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
- Targeted invitation to non-traditional stakeholder individuals

Brief explanation.

First, the PRAEXS 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 other extension personnel identify and invite members of producers associations, individual farmers, faculty and students, government officials, and community organizations with an interest in the commodity's work and related research programs. The Associate Dean or the commodity leader send personal invitations to relevant government officials and positional leaders of stakeholders groups. These meetings are also announced in the PRAEXS web page and frequently printed in the local agricultural monthly newspaper. 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, project directors knowledgeable of their targeted audience, extension agents, and through local advisory committees established by CAS administrators. Stakeholders are asked about the most critical issues affecting their commodities and localities and about our research priorities. This information is summarized in a report made by the commodity and program leaders.

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

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Meeting specifically with non-traditional individuals

Brief explanation.

Input from stakeholders is collected at the meetings convened by commodity and program leaders, and in activities with non-traditional groups such as organic farmers. At the end of the meeting stakeholders are asked to fill a written evaluation that includes questions about the most critical issues affecting their commodities, localities, or production systems, and about our research priorities. This information is summarized in a report made by the commodity, program leader, or administrator convening the meeting.

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 has 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 PRAEXS Research Office during the year. The inputs received during past years from traditional and non-traditional stakeholders and from government officials were also critical for starting a pilot organic experimental farm and for investing in the remodeling of research infrastructure into a Certified Quarantine Facility to better meet the threats presented by invasive species.

Brief Explanation of what you learned from your Stakeholders

The most important continuing concerns of stakeholders participating in commodity meetings and program evaluations are: (1) the lack of quality seed availability in the island and its relationship with local food security; (2) the need of alternative management strategies for the control of new pests and diseases; and (3) the need to find economical alternatives to expensive production inputs driving up local production costs--energy, fertilizers, and labor in particular. In response to these concerns PRAEXS has been expanding the production and distribution of improved cultivars developed over the years in our substations around the island; have increased crop protection studies and research activities related to the detection and management of damaging pests and diseases; have upgraded research infrastructure facilities such as the Center of Excellence in Quarantine and Invasive Species; and continues to adapt its programs' outlook towards the search for economical management practices. In our Meat and Milk Production Systems program, for example, crop rotations including annual legume green manures are being evaluated for the production of high quality forages, in an effort to control costly synthetic fertilizers applications. In other programs, studies are in progress on other alternative fertilization methods which can potentially increase output while controlling costs, and in the evaluation of sustainable energy alternatives with the potential of reducing energy costs. Stakeholders have also provided recommendations on how to improve the ways in which we traditionally share information with them. In response to these latter suggestions researchers are using other alternative methods, such as podcasts and web pages, to extend results to a wider audience.

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	4526160	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	3559500	0
Actual Matching	0	0	2838193	0
Actual All Other	0	0	80917	0
Total Actual Expended	0	0	6478610	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	76845	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Global Food Security and Hunger - Milk and Meat Production Systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
202	Plant Genetic Resources			9%	
205	Plant Management Systems			9%	
213	Weeds Affecting Plants			9%	
301	Reproductive Performance of Animals			3%	
302	Nutrient Utilization in Animals			9%	
303	Genetic Improvement of Animals			24%	
306	Environmental Stress in Animals			5%	
308	Improved Animal Products (Before Harvest)			14%	
311	Animal Diseases			5%	
313	Internal Parasites in Animals			5%	
401	Structures, Facilities, and General Purpose Farm Supplies			3%	
503	Quality Maintenance in Storing and Marketing Food Products			5%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	4.0	0.0
Actual Paid	0.0	0.0	4.2	0.0
Actual Volunteer	0.0	0.0	0.7	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	986048	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	671636	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	51962	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Of 14 articles based on our research results accepted by peer-review journals (8 published during 2014 and 6 in press at year's end), 10 involved different aspects of production and utilization of forages as silage, hay and grazed herbage, 3 were on the quality of locally produced meats and 1 on swine reproduction. The topics of 25 presentations at meetings of international or local scientific societies were distributed as follows: short-haired, heat tolerant Holstein cattle (3); mitigation of thermal stress in dairy cattle (2); animal diseases and parasitism (4); forage production and utilization (3); weed control in pastures (4); and poultry production (1). In most cases the first authors of these presentations were graduate students. There were also two publications in non-technical language on beef cattle topics. Extension efforts to educate producers about topics relevant to their operations, using a variety of methods of communication, were very active during the year. A number of field day and training sessions were well attended. Consulting services were provided for the benefit of both government officials and private sector parties.

2. Brief description of the target audience

1. Producers of the following classes of livestock and related products: bovines for milk and meat, sheep and goats for meat, goats for milk, swine and rabbits for meat, poultry for meat and eggs, and forages for sale
2. People working in services and sales in businesses related to livestock production, including producers of concentrate feeds, feed additives or supplements; semen and embryo transfer services; agricultural and veterinary supplies and equipment; milking equipment and agricultural machinery; and computer software
3. Self-employed professional consultants
4. Personnel of financial institutions, including banks and cooperatives and the Farm Credit Service
5. Officials of the insular and federal Department of Agriculture and other interested government agencies
6. Extension Service agents
7. Members of the teaching faculty
8. Graduate and undergraduate students
9. High school students with interest in livestock production
10. Members of the general public

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	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: 2014
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	8	8

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of meetings held with stakeholders to discuss the situation of each relevant industry and corresponding research priorities
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of popular (non-refereed) publications to report research results and other pertinent information for the benefit of producers and other interested parties

Year **Actual**

2014	2

Output #3

Output Measure

- Number of field days, training sessions and other types of educational services provided for producers

Year	Actual
2014	9

Output #4

Output Measure

- Number of publications in refereed scientific journals.

Year	Actual
2014	8

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of producers participating in field days or training sessions who express willingness to adopt demonstrated management practices on their farms
2	Yearly percentage increase or decrease of on farm income from sale of livestock and related products in Puerto Rico
3	Number of animals of genetically improved breeding stock, from the University of Puerto Rico herd, sold to local beef producers to improve the genetic quality of their herds.

Outcome #1

1. Outcome Measures

Number of producers participating in field days or training sessions who express willingness to adopt demonstrated management practices on their farms

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To be profitable, livestock production increasingly needs pertinent information about up-to-date management practices. Profit margins are narrow, thus efficiency is required; this efficiency depends on organization and supervision of day-to-day operations combined with sound business administration, which in turn makes continuing education and acquisition of the underlying knowledge extremely important. Extension activities provided by university personnel are an outstanding resource in this regard.

What has been done
As indicated in output #3, in 2014, a total of 9 field days and training sessions were conducted by the combined efforts of Extension Service and Experiment Station personnel. Attendance and interest of participants were high at these events.

Results
Undoubtedly considerable progress was made in furthering knowledge about recent developments in science and technology related to livestock production, as well as more traditional information about management practices that need to be repeatedly reemphasized. It was not possible to capture the attention and gain the cooperation of all producers attending educational events to obtain their expressed degree of willingness to implement the recommended practices. However, in all cases some producers showed genuine interest and presumably an inclination to take action.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems

213	Weeds Affecting Plants
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
306	Environmental Stress in Animals

Outcome #2

1. Outcome Measures

Yearly percentage increase or decrease of on farm income from sale of livestock and related products in Puerto Rico

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The agricultural sector of the Puerto Rican economy now contributes far less than it did historically and far less than it could if adequately attended to. Total income from livestock and related products has shown only modest ups and downs over the past five fiscal years, rather than the sustained progress needed to achieve a reasonable level of food security and revitalize the agricultural economy. If the contribution made by research and extension efforts is not reflected in increased on-farm income, their main goal will not have been achieved and the justification for continued investment of resources in them may be questioned.

What has been done
Extension and research activities have provided important knowledge that livestock producers need to improve efficiency and profitability of their operations. Such results can be achieved, in the case of producers with operations of fixed size, either by obtaining an increase in production with the same inputs or by maintaining the same production with lower inputs. For other producers who are either entering the livestock sector or expanding the size of existing operations, consulting services are provided upon request to verify the economic feasibility of the proposed expansion and ensure wise initial investment and a cost efficient operation.

Results
Between fiscal years 2012 and 2014, total on-farm income from livestock and related products (including forages for sale) increased from $425.7 to $439.9 millions. The increase represented a

relative change of 1.03%. Milk income of $214 millions represented 48.6% of the total, but showed a relative decline of nearly 1% from the previous year. In second place was poultry meat with $81.9 millions, which represented a 1.08% increase over the year before. Similar slight relative increases were registered by the pork and beef sectors, whereas income from eggs showed a strong improvement of 25% reaching $19.3 millions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
308	Improved Animal Products (Before Harvest)
401	Structures, Facilities, and General Purpose Farm Supplies

Outcome #3

1. Outcome Measures

Number of animals of genetically improved breeding stock, from the University of Puerto Rico herd, sold to local beef producers to improve the genetic quality of their herds.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	136

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Of Puerto Rico's livestock sector, beef producers find it most difficult to operate profitably. Unregulated beef imports make for an unlevel playing field as local producers have higher production costs and have to comply with more stringent sanitation and environmental protection regulations than those of exporting countries. In addition, Puerto Rico lacks a beef classification system; price discrimination is common against female animals and generally low prices paid for animals sold for slaughter. A number of these problems are beyond the scope of scientific research and extension, but one important contribution that our institution can make is to provide breeding stock to genetically improve commercial beef cattle herds, thus helping to make them more profitable.

What has been done
The beef cattle research project at Mountain Farm in north-western Puerto Rico has developed an excellent herd of the Senepol breed and crossbred animals of Senepol with several other well-known beef breeds. For more than 25 years, surplus animals beyond those needed for herd

development or use in specific experiments, have been sold to be incorporated into commercial beef cattle herds.

Results
In the annual sale of 2014, a total of 136 animals were sold, including 40 bulls, 40 adult cows, 27 heifers, 18 male and 11 female young animals. The buyers were owners of 17 different commercial herds located in the west (83), north (43), south (7) and east (3) regions of the island (in parenthesis, number of animals acquired in each case). The addition of these genetically superior animals to the commercial herds, which in many cases were previously composed of unselected animals, has raised the average level of genetic potential for productive performance, and carcass and meat quality. Furthermore, it has made beef producers more aware of the need for genetic improvement of their herds.

4. Associated Knowledge Areas

KA Code	Knowledge Area
303	Genetic Improvement of Animals
308	Improved Animal Products (Before Harvest)

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Other ((see below))

Brief Explanation

• Continued long-term economic recession in Puerto Rico with effects on consumer purchasing power and food selection
• Lack of long-term government planning for the agricultural sector, no continuity, subject to changes in focus and the government incentives accompanying every 4-year electoral cycle
• Insufficient private sector investment in agricultural enterprises
• Continued conversion of land from agriculture to other uses and under-utilization of the agricultural lands still remaining
• Unpredictability of future costs of petroleum and its derived products needed for on-farm production and processing and distribution of local food; also costs of imported feed grains
• Lack of a sufficient number of young people, well prepared, willing and financially able to engage in productive agriculture with successful results

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Satisfactory progress is observable in the gradual integration of scientific personnel of the two agencies, Agricultural Experiment Station and Agricultural Extension Service, in planning and carrying out research pertinent to the needs of the local livestock industries, and dissemination to stakeholders of the knowledge gained from such research.

Key Items used for judging the progress of the program:

1. Attendance of producers at educational activities and their level of interest in acquiring useful knowledge with possible applicability on their farms, and the dialogue in which producers make known to university personnel the problems that they face that might be amenable to further scientific research.
2. Willingness of some producers to have research under UPRM auspices carried out at their private farms.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Climate Change - Integrated Management of New and Emerging Pest and Diseases

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
211	Insects, Mites, and Other Arthropods Affecting Plants			19%	
212	Diseases and Nematodes Affecting Plants			27%	
215	Biological Control of Pests Affecting Plants			20%	
216	Integrated Pest Management Systems			34%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.7	0.0
Actual Paid	0.0	0.0	1.5	0.0
Actual Volunteer	0.0	0.0	0.7	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	969193	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	715661	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Integrated Management of New and Emerging Pest and Diseases at PRAEXS support the enhancement of natural enemies, biocontrol and mitigation of new pest introductions. The Center for Invasive Species and Quarantine in Puerto Rico evaluated horticultural oil and imidacloprid and they were shown to be compatible with the release of natural enemies to control H. pungens, offering a selectivity effect to a wasp L. hypogeococci and a coccinellid predator, S. flavifrons. A series of alternative practices were disseminated to banana and plantain growers and extension educators for nematode control. Stakeholders acquired knowledge of effective management of nematodes such as a short rotation scheme with velvetbean and organic matter application, which will decrease the use of commercial nematicides. Results will contribute to increasing the cost-benefit ratio of nematode control and decreasing the risks for human health and the environment associated with the use of chemical nematicides.

Small growers were the target audience for the coffee berry borer integrated control recommendations that include keeping the CBB population below the economic threshold levels by adopting integrated management strategies such as anticipating and continuously monitoring pest outbreaks, maintaining optimum shade, pruning of coffee bushes, harvesting and processing the berries and using biological control with Beauveria bassiana. These results were disseminated to agronomists and farmers in professional and community meetings.

Few studies in Puerto Rico have determined the presence of phytoplasma from important crops. Using end point PCR with universal and specific primers, phytoplasmas were identified in periwinkle, pigeon pea, citrus, coffee and tabebuia. Insect genera of Empoasca kraemeri, Melornemis antillarum and Colpoptera maculifrons were positive for PPWB phytoplasma based on results from conventional PCR and DNA sequence analysis. These findings indicate that these insects fed upon the aforementioned plant species, and may act as potential phytoplasma vectors in the field.

Approximately, 200 stakeholders from a total of 466 that visited the Plant Disease and Insect Clinic received recommendations about the management of new and emergent diseases in 16 different agricultural crops. Emphasis was on reducing the use of insecticides in horticultural crops affected by viral diseases and the profitability and environmental impact of the practices. The citrus orchards of Adjuntas and the "Citrus Germplasm Bank of Isabela substations were evaluated for graft-transmissible diseases. Observations of the parent material, phytosanitary status and vigor were carried out and citrus samples were collected, tested and found free of symptoms of graft-transmissible pathogens based on the initial visual inspection that included gummosis, citrus blight, citrus canker, citrus greening, decline, leprosis and evidence of unacceptable bud mutation. Laboratory analyses were carried out for Citrus Greening (CG), Citrus Tristeza Virus (CTV) and Citrus Variegated Chlorosis. Parent trees that were positive for CG and CTV were eliminated and healthy trees were covered with insect-proof screen. This program will distribute clean citrus material to growers.

2. Brief description of the target audience

- Extension specialists and agents
- Producers and commodity groups
- Researchers in the Vegetable Industry
- Academic programs faculty and students
- Federal and State Agricultural Agencies (PRDA, USDA/APHIS, USDA/ARS, USDA/NRCS).

• American Phytopathological Society (APS), Agronomy Society of America, Horticultural Society, Puerto Rican Agricultural Sciences Society, Entomological Society of America.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	348	466	250	250

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	10	10

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2014	4

Output #2

Output Measure

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

Year	Actual
2014	6

Output #3

Output Measure

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

Year	Actual
2014	4

Output #4

Output Measure

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

Year	Actual
2014	12

Output #5

Output Measure

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

Year	Actual
2014	10

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
2014	3

Output #7

Output Measure

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

Year	Actual
2014	4

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
4	Number of stakeholders knowledgeable of climate changes issues and their importance in agricultural production.

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
2014	250

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New key pests, weeds and diseases are introduced each year into the island. Constantly evolving production systems pose new challenges to IPM as pest complexes change and adapt. There?s a generalized lack of management knowledge among producers and even among extension agents and Department of Agriculture personnel. This lack of knowledge causes the use of unsuitable pesticides, the application of higher doses than needed and death of beneficial and non-target organisms. We need to address these environmental concerns and reinforce the use of newer, more environmentally sound crop management methods.

What has been done
Approximately 150 stakeholders that visited the Plant Disease Clinic received recommendations about the new and emergent diseases and their management in 16 different agricultural crops. Emphasis was given to reducing the use of insecticides in horticultural crops affected by viruses in hydroponics. In a CG workshop, 47 growers and extension specialists received information in the nutritional program for the management of citrus greening and psyllid control tactics.

Results
Farmers are increasingly aware of alternative pest and disease management methods. Coffee growers, for example, learned the following control strategies against the coffee berry borer (CBB): keeping the CBB below the economic threshold, continuously monitoring the CBB, maintaining the optimum shade, pruning the coffee bushes, using the biocontrol Beauveria bassiana, and the timely harvesting and processing of the coffee berries.

4. Associated Knowledge Areas

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

212	Diseases 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
2014	18

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growers increasingly visit plant disease and insect detection facilities in Juana Diaz in search of diagnostics and recommendations for diseased crops.

What has been done
The Plant Disease and Insect Clinic in Juana Diaz engages growers who visit the clinic in the process of disease detection and identification. This is essential for growers and general public acquisition of knowledge and to promote ownership of the disease and pest detection process. Disease and Pest detection has been fast and accurate and improvement in the methods used for pathogen identification is reflected in the number of new diseases identified, and in the number of publications submitted and published.

Results
The largest producer of tomatoes and several hydroponic producers of lettuce, tomatoes and peppers in Puerto Rico have adopted the recommendations issued for Tomato Chlorotic Spot Virus (TCSV) prevention. By scouting the thrips vector and producing seedlings in insect-proof facilities plus the eradication of symptomatic plants, losses were decreased in the hydroponic facilities and less incidence of TCSV was reported in field tomatoes.

4. Associated Knowledge Areas

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

212	Diseases and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

Outcome #4

1. Outcome Measures

Number of stakeholders knowledgeable of climate changes issues and their importance in agricultural production.

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
- Other (Reduction of AES personnel)

Brief Explanation

While the continued stagnation of the Puerto Rican economy affects everyone it is increasingly difficult to keep pace with the rapid entry of new diseases in the island with a reduced faculty roster due to retirement and very few new hirings at the university. Personnel limitations are perhaps the biggest obstacle we have for making more progress toward meeting our goals.

V(I). Planned Program (Evaluation Studies)

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

Global Food Security and Hunger - Plant genetic resources, breeding and production systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			10%	
202	Plant Genetic Resources			40%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			8%	
204	Plant Product Quality and Utility (Preharvest)			7%	
205	Plant Management Systems			35%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	11.3	0.0
Actual Paid	0.0	0.0	8.5	0.0
Actual Volunteer	0.0	0.0	1.0	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	991738	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	958375	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

- Acquired, evaluated, conserved and distributed plant germplasm
- Developed and released sweet chili pepper lines, cultivars and germplasm
- Improved bean yield potential; identified and implemented sustainable agricultural systems
- Developed a program for supplying high quality "USDA Organic" seeds to local farmers
- Introduced and evaluated orange-fleshed sweet potato clones
- Conducted a survey of nutrient status in soil and plant tissue in farm fields for arracacha
- Presented research results in local, national, regional and international scientific meetings
- Published research results in local newspapers, bulletins, proceeding and refereed journals
- Celebrated joint field days, seminars and commodity meetings with PRAES and PR Department of Agriculture (PRDA).
- Continued identifying critical issues of this program area from stakeholders, especially through commodity meetings
- Published technological packages of crop production systems for cabbage and other vegetable crops

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

2014	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: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	10	10

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Records of the number and type of germplasm accessions distributed to scientists and the public.
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of participants in the field days coordinated with Extension or the Department of Agriculture

Year	Actual
2014	592

Output #3

Output Measure

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

Year	Actual
2014	30

Output #4

Output Measure

- Number of refereed publications.

Year	Actual
2014	10

Output #5

Output Measure

- Number of non-refereed publications.

Year	Actual
2014	24

Output #6

Output Measure

- Number of presentations in scientific meetings.

Year	Actual
2014	27

Output #7

Output Measure

- Number of research proposals submitted addressing Global Food security and hunger.

Year	Actual
2014	2

Output #8

Output Measure

- Number of MS Thesis related to Global Food security and hunger.

Year	Actual
2014	4

Output #9

Output Measure

- Number of new varieties released by PRAES

Year	Actual
2014	2

Output #10

Output Measure

- Number of activities to inform stakeholders about established projects and their benefits

Year	Actual
2014	16

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.
3	Number of locally produced starchy crops with increased output according to Dept. of Agriculture statistics
4	Number of fruit crops with increased output according to Dept. of Agriculture statistic
5	Number of vegetable crops with increased output according to Dept. of Agriculture statistics
6	Number of stakeholders gaining knowledge on organic agricultural practices and acquiring certified organic seeds

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Farmers in PR need to sustainably increase yields and reduce production costs in order to compete in an open market economy.

What has been done
Printed copies of technological packages of production practices for different crops are distributed to farmers, extension agents and specialists, PR and Federal Government officials, educators, private sector professionals in agriculture and the public. A technological package for cabbage was published in 2014 and drafts for watermelon and taniers are in the final stages of completion. BMP are presented and discussed at field days and workshops by the PRAEXS and the Extension Service.

Results
PRAEXS provides vital support for the continued production of traditional crops because seed, and vegetative planting material, is not available from the private sector in PR. The number of stakeholders, especially farmers, attending commodity meetings, field days, seminars and workshops sponsored by PRAEXS continues to increase which suggests an increased willingness of farmers 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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Lack of seeds of improved germplasm continues to be a major production constraint identified by extension agents and growers at our yearly commodity meetings with stakeholders.

What has been done
The Puerto Rico Department of Agriculture contracted the PRAEXS to produce seeds and vegetative planting materials as well as seedlings for distribution to growers. The Isabela Substation increased sales of pigeon pea seeds, beans, Spanish squash, corn, and Crotolaria; as well as planting material of taniers and plantains to farmers. Both the Juana Díaz and the Isabela Substations sold grafted fruit trees of mango, avocado and citrus to growers. The Adjuntas Substation sold 57,850 coffee seedlings, 1,625 citrus trees and 4,364 pounds of coffee seeds. Each of the six substations produces seeds and planting materials for growers.

Results
The land area planted with improved varieties has increased over the past few years. In addition to those mentioned above, records at the substations show that 5,920 lb of beans; 15,538 lb of taniers; 1,915 lb of pigeon peas; and 452 lb of corn from the Isabela Substation were sold to farmers and to the public wishing to expand their plantings.

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 #3

1. Outcome Measures

Number of locally produced starchy crops with increased output according to Dept. of Agriculture statistics

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Production of root and tuber crops has decreased by more than 80% over the past sixty years, while consumption has decreased by a much smaller percent.

What has been done
The PRAES has an active research program on starchy crops. New varieties have either been developed locally or imported. Management practices have resulted in increased yields. Research results on starchy crops, together with outreach by the extension specialist and agents have resulted in increased production.

Results
Puerto Rico Department of Agriculture statistics reflect increases in production of bananas by 68%; sweet potatoes by 21%; yams, 27%; taro, 346%; celeriac, 57%; and cassava, 8% between the 2012/13 and 2013/14 seasons. Plantain and breadfruit production remained the same while tanier production decreased by 10%.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems

Outcome #4

1. Outcome Measures

Number of fruit crops with increased output according to Dept. of Agriculture statistic

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fruit crops are an important sector of PR?s agricultural production. Diseases such as Citrus Greening, Phytophtora root rot of avocados, anthracnose of mangoes, among others, and poor management practices by some farmers, present severe constraints for maintaining or expanding fruit crop production.

What has been done
During the past year research has concentrated on Citrus Greening and other citrus diseases, and on purifying pineapple varieties whose seeds appeared to be degenerating.

Results
Puerto Rico Department of Agriculture statistics reflect increases in the production of pineapple by 163%; watermelon, 95%; honeydew melons, 308%; cantaloupe melons, 300%; papaya, 130%; avocadoes, 23%; mangoes, 3%; limes, 13%; and grapefruit, 33% between the 2012/13 and 2013/14 seasons. Production of oranges, passion fruit and soursop remained the same during both seasons.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems

Outcome #5

1. Outcome Measures

Number of vegetable crops with increased output according to Dept. of Agriculture statistics

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Diseases and insects are major constraints for tropical vegetable production. Crop management and IPM practices need to be evaluated. Supply of certified seed of traditional vegetables (Spanish squash, eggplant, sweet cherry pepper and others should be kept at PRAEXS. Crop management practices for organic farmers and under climate change should be evaluated.

What has been done
Germplasm evaluation of new hybrids and traditional varieties has continued. Irrigation studies in the semi-arid vegetable production region were conducted. Organic seed production of vegetable seeds was continued at the Lajas and Gurabo Substations of the PRAEXS.

Results
Puerto Rico Department of Agriculture statistics reflect increases in the production of sweet pepper by 40%, Spanish squash by 72%, eggplant 39%, onion 42%, cucumber 39%, sweet cherry pepper 69%, lettuce 20%, beans in their pods by 85%, and dry beans by 4% between the 2012/13 and 2013/14 seasons. The production of tomatoes was reduced by 5% and that of cabbage showed a 30% decrease.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems

Outcome #6

1. Outcome Measures

Number of stakeholders gaining knowledge on organic agricultural practices and acquiring certified organic seeds

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Demand exists for organically grown crops. Current local supply of organically grown crops is very limited. Organic seeds must be imported at high costs from suppliers in temperate zones. Organic seeds of crops that grow in tropical conditions are necessary to meet local demand. A very small area has been designated as organic farms.

What has been done
Areas within the Gurabo and Lajas Substation of the PRAES have been certified as organic. The PRAEXS has been distributing seeds with the ?USDA Organic? label since receiving the final organic certificate from the Quality Certification Services (Gainesville, Florida) in 2010.

Results
Since obtaining the QCS organic certification, 1,709 pounds of 59 different vegetables, culinary herbs and cover crops with the ?USDA Organic? label have been distributed at the Lajas organic seed production farm. Some of the organic seeds produced are for tropical pumpkin, eggplant, okra, upland rice, corn, cilantro, beans, winged beans, cowpea, mucuna, Crotalaria and Canavalia. At Gurabo, planting material and seed of sweet potato, cucumber, sugarcane, sweet cherry pepper, black-eyed pea, and pigeon pea, among others, have also been distributed to interested stakeholders.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
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

No hurricanes hit PR in 2014. Drought conditions were prevalent during the first half of 2014 affecting the island's agricultural production. Puerto Rico has been in a recession for the past nine years. In February 2014, the credit rating companies downgraded Puerto Rico's general obligation bonds and related debt to speculative grade. The debt of the University of Puerto Rico falls into this category known as junk bonds. Most research faculty members will reach retirement age within the next five years, and a very small number of new research faculty are being recruited. A serious problem exists at the Río Piedras Center of PRAEXS with infrastructure (electricity), which affects instruments in the labs as well as telephone and internet communications.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Records of seeds, planting material and tree seedlings of cultivars, lines or varieties developed or evaluated by the PRAEXS are maintained at the substations. The records provide a measure of the impact of the variety development and variety evaluation program. At the Isabela Substation, 15,538 pounds of taniers were provided to the PRDA for distribution to farmers, representing the majority of the healthy planting materials sold to farmers. Records are kept of bean sales (5,960 pounds), tropical pumpkin (76 pounds), corn (452 pounds), cilantrillo (169 pounds) as well as grafted trees of citrus (390 trees), avocadoes (125 trees) and plantain vegetative planting material. The "USDA Organic" seed distribution at the Lajas Substation is described in Outcome #6, the distribution of coffee seedlings and seed and of citrus plants at the Adjuntas Substation is described in Outcome #2.

In addition, commodity meetings that include farmers, extension specialist, extension agents, Department of Agriculture officials and researchers are being used to obtain inputs concerning new technologies being evaluated and other aspects of the program under evaluation. The information that was obtained is being used to improve the design of the program and dissemination strategies.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Climate Change: Natural Resources and Environment

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
101	Appraisal of Soil Resources			7%	
102	Soil, Plant, Water, Nutrient Relationships			13%	
103	Management of Saline and Sodic Soils and Salinity			3%	
104	Protect Soil from Harmful Effects of Natural Elements			8%	
111	Conservation and Efficient Use of Water			12%	
112	Watershed Protection and Management			13%	
121	Management of Range Resources			3%	
123	Management and Sustainability of Forest Resources			3%	
133	Pollution Prevention and Mitigation			8%	
136	Conservation of Biological Diversity			17%	
141	Air Resource Protection and Management			2%	
211	Insects, Mites, and Other Arthropods Affecting Plants			7%	
212	Diseases and Nematodes Affecting Plants			2%	
403	Waste Disposal, Recycling, and Reuse			1%	
405	Drainage and Irrigation Systems and Facilities			1%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.5	0.0
Actual Paid	0.0	0.0	3.4	0.0
Actual Volunteer	0.0	0.0	0.8	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	549756	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	438035	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	28955	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The main goal of the Climate Change and Sustainable Energy: Natural Resources and Environment research program (CCSE-NRE) continues to be to develop, perform and support scientific research regarding the impact of agricultural practices on the environment and natural resources of Puerto Rico. The program addresses key Agricultural Experiment Station mission goals by supporting both the Department of Agriculture and the Natural and Environmental Resources Department.

During 2014 soil management research promoting the improvement in soil quality by increasing recalcitrant soil organic matter (RSOM) continued with the quantification and characterization of RSOM in weatherized soils as a function of conservative practices. The integrated soil management system promoted incorporates three soil conservation practices: green manure amendments, compost, and effective microorganisms.

The development of quantitative thresholds of impairment for nutrients continues to be a key priority of our watershed protection and management research program. Studies providing reliable scientific data on the contribution of agriculture in relation to other pollution sources, and promoting a reduction in the amount of nutrients released into soil and water, validated important results for informing regulatory policy decisions. The Environmental Quality Board of Puerto Rico (PREQB) recently modified the island's Water Quality Standards of Rivers and Streams as relates to nutrients. Results from one of our current Hatch projects validated numeric nutrient criteria estimates developed in a previous study using a statistical distribution approach. Confirmation of previous estimates using a biological index component was pivotal in the regulatory effort.

The prevention and control of invasive species through management approaches for biodiversity conservation and restoration also remains an important priority of our program. Both field-and laboratory-based activities were conducted last year to continue identifying and pursuing insights into the role of emerging or invasive insect pest species in Puerto Rico. Digital images were gathered of over 50 common insect species from the Mangrove & Coastal forest plant assemblage. More than 200 high quality digital images are now available for selection and publication.

Other research priorities identified by program stakeholders, and partially addressed in our projects, are: a digitalized inventory of agricultural land use in crop production and other land uses; appraisal of this resource availability and suitability for specific uses; and development of sustainable agricultural

production practices to protect and enhance natural ecosystems. Research results have been disseminated through peer reviewed publications, non-refereed articles, and presentations in trainings, research demonstration activities and meetings with stakeholders.

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	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: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	8	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2014	16

Output #2

Output Measure

- Number of Peer Reviewed publications.

Year	Actual
2014	8

Output #3

Output Measure

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

Year	Actual
2014	15

Output #4

Output Measure

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

Year	Actual
2014	4

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of stakeholders gaining knowledge on pollution prevention and mitigation practices for soil and watershed protection and management.
2	Number of persons adopting practices for watershed protection
3	Number of persons gaining knowledge on biodiversity threats and losses, and on prevention practices.
4	Number of farmers adopting methods to increase soil organic matter content
5	Number of stakeholders gaining knowledge of efficient water use and conservation practices.
6	Number of stakeholders gaining knowledge effects on invasive species management practices.
7	Number of stakeholders gaining knowledge on managing approaches for conserving and restoring biodiversity and on the impact of agricultural management practices on natural ecosystems.
8	Number of students (graduates and undergraduates) receiving training and work experience in this research program.

Outcome #1

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural residues in Puerto Rico have not been considered a manageable resource, but a waste byproduct. Pollution reduction can be achieved through proper organic resource management. Windrow composting offers the possibility of composting large quantities of organic waste that can be managed with relatively low operational cost and low energy consumption.

What has been done
A project was established to validate and demonstrate the use of windrow composting of various agricultural residues. The research conducted also validated the use of microorganisms in the odor control process. To manage large quantities of agricultural residues, a windrow composting and water management design system was adapted to the humid tropical conditions of Puerto Rico. The project was mostly supplied with coffee pulp from various coffee processing plants and occasionally received chicken manure and orange peels from an orange processing plant.

Results
The project's research site, PRAEXS Adjuntas substation, has become a model of proper composting practices. Project results have been widely disseminated to local and international audiences through several videos describing the windrow composting facility and other aspects of the composting process such as the use of temperature to monitor the compost pile. At the time the final report was submitted the audience for the videos numbered more than 900 viewers in Puerto Rico and more than 3,000 in Latin America and the US. Several field visits were also organized to share the project results with local stakeholders.

4. Associated Knowledge Areas

KA Code	Knowledge Area

101	Appraisal of Soil Resources
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse

Outcome #2

1. Outcome Measures

Number of persons adopting practices for watershed protection

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nutrient over-enrichment is highly detrimental to the sustainability of waters. The USEPA has the mandate to develop quantitative thresholds of impairment of nutrients for watershed and reservoirs on the island. The development of biological indicators of stressor conditions is an essential component to implementing regulatory limits or standards to control nutrient over-enrichment in rivers/streams of Puerto Rico. The target audiences for 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
A project was established to evaluate the relationship between nutrients and recurrent flood events on the growth rate and biomass accumulation of periphyton in moderately to nutrient enriched rivers of Puerto Rico. An opinion poll is being conducted of a particular community (NGO) of river stakeholders to establish what constitutes acceptable/nuisance levels of periphyton biomass for recreational purposes in rivers of Puerto Rico.

Results
The Environmental Quality Board of Puerto Rico recently modified the Water Quality Standards of Rivers and Streams of the island as related to nutrients. Results from our current Hatch project validated numeric The Environmental Quality Board of Puerto Rico recently modified the island?s Water Quality Standards of Rivers and Streams as relates to nutrients. Results from our current Hatch project validated numeric nutrient criteria estimates developed in a previous study using a

statistical distribution approach. The confirmation of previous estimates using a biological index component was pivotal in the regulatory effort. Results have been disseminated through seminars. The process of scientific manuscript submission is in progress.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Number of persons gaining knowledge on biodiversity threats and losses, and on prevention practices.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Invasive species are posing a serious challenge that requires a decision-making framework based on the prioritization of species for control, regulation and public education programs. Methods are needed to identify those non-native species that pose ecological and economical threats in order to prioritize those that should be targeted for regulation, control or both.

What has been done
Both field-and laboratory-based activities were conducted to continue identifying and pursuing insights into the role of emerging or invasive insect pest species in Puerto Rico. In addition to field collections, efforts have been made to secure reliable identification methods using museum reference materials, extant literature, and historical collections. Following our initial model of constructing pictorial records of known and newly introduced species, digital images were gathered of over 50 common insect species from the Mangrove & Coastal forest plant assemblage. More than 200 high quality digital images are now available for selection and publication.

Results
We have documented the presence of new potential pests. Among these is the first record for the invasive aphid Greenidea psidii (Hemiptera: Aphididae) from Asia, a potential pest of guava and other myrtaceous crops. We also found several specimens of the Dynastine beetle, Gymnetis strigosa, a northern South America native found feeding on the endangered Marsdenia woodburyana (Asclepidaceae). An introduced pit scale, Planchonia stentae (Hemiptera: Sternorrhyncha: Asterolecaniidae) was also found attacking the endangered Mitracarpus polycadus in Guánica. This scale is another well-known invasive species and a new record for Puerto Rico. Finally, we reported the presence of the croton scale Phalacrococcus howertoni (Hemiptera: Sternorrhyncha: Coccidae) in St. Croix and in Puerto Rico. This invasive scale is likely to become a serious problem in ornamental settings and in urban forests.

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
212	Diseases and Nematodes 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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Unsuitable agricultural practices have exacerbated soil degradation worldwide, thus limiting food production. Loss of soil organic matter is a major effect associated with soil degradation. Transition to a sustainable agriculture could be a long-term process that starts with the soil, its health and the environment. Many factors can affect the rate of transition: varied tropical clay soils, compost types, and rainy, humid and changing environments, posing a challenge for

sustainable production.

What has been done
Studies were conducted on the transition to sustainable agriculture and the rate at which it can occur. Four important agricultural clay soils of varying characteristics were supplemented with organic amendments in order to quantify and simulate the long-term effects of amendments on crop yield. The frequency and quantity of compost applied to the soil was studied over a four-year period with tomato and onion crop rotations to observe a possible reduction of inorganic fertilizer needs based on soil analysis.

Results
The incorporation of cover crops, compost amendment and application of compost tea increased total soil organic matter and recalcitrant organic matter in tropical soils. The physical, chemical and biological properties of soils were significantly increased by the above-mentioned amendment treatments. The results of this study were shared and continue to be shared on the website compostapr.com. The process of sharing information allows farmers and the general public to prepare individual management plans after a small amount of training through the web page presentations.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Number of stakeholders gaining knowledge of efficient water use and conservation practices.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Irrigation is an important factor in areas in which rainfall is limiting crop production. In Puerto Rico, 40% of the groundwater is used for irrigation. Farmers over-irrigate in an attempt to increase yields, resulting in water logging poorly permeable soils, or nitrogen losses in soils with higher permeability, thus contaminating groundwater. Better irrigation management, conservation, and utilization should help to alleviate the dilemma between agricultural production and water for human consumption.

What has been done
A project was established to compare irrigation-scheduling technologies and develop grower-appropriate scheduling products. Best management practices for the application of agrochemicals were also developed.

Results
More farmers and producers have understood the importance of proper management of drip irrigation in fruit trees, vegetables and starchy crops. Proper use of these systems (micro-irrigation or drip irrigation) reduces production costs, increases water use efficiency, and reduces pollution in groundwater. Farmers' trainings in the field were achieved, including a women's group among them. It was proven feasible to use subsurface micro-irrigation to produce vegetables and farinaceous crops in rotation for several years on the south coast of Puerto Rico. The University of Puerto Rico began to play an important role in the Caribbean with the use of remote sensing technology to estimate regional evapotranspiration (ET) and thereby promote better use of irrigation water resources.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Number of stakeholders gaining knowledge effects on invasive species management practices.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Number of stakeholders gaining knowledge on managing approaches for conserving and restoring biodiversity and on the impact of agricultural management practices on natural ecosystems.

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Number of students (graduates and undergraduates) receiving training and work experience in this research program.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	15

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Outstanding students at the undergraduate and Master?s levels need training support in order to fill national identified expertise demands in the Agricultural and Natural Resources sciences.

What has been done
Funding from research projects has been allocated for the support of student?s training, work experience and completion of their Master?s degree in priority research areas within the Agricultural and Natural Resources sciences.

Results
Four students completed their master degree during last year. Recruitment and retention of talented students interested in pursuing graduate studies has increased. Students recruited under the program have shown a tendency to continue graduate studies in disciplines and topics related to the research program.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
104	Protect Soil from Harmful Effects of Natural Elements
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
133	Pollution Prevention and Mitigation

211	Insects, Mites, and Other Arthropods Affecting Plants
403	Waste Disposal, Recycling, and Reuse
405	Drainage and Irrigation Systems and Facilities

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

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

Key Items of Evaluation

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

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Global Food Security and Hunger - Agricultural Economics, Marketing, and Community Development

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
601	Economics of Agricultural Production and Farm Management			25%	
602	Business Management, Finance, and Taxation			5%	
604	Marketing and Distribution Practices			25%	
605	Natural Resource and Environmental Economics			10%	
606	International Trade and Development Economics			5%	
607	Consumer Economics			5%	
608	Community Resource Planning and Development			10%	
610	Domestic Policy Analysis			13%	
902	Administration of Projects and Programs			2%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.7	0.0
Actual Paid	0.0	0.0	0.6	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	18727	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	20681	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 undertaken to identify new market niches and promising new products, as well as to determine farmers' costs of production, consumer preferences, marketing margins, and farmers' and other participants' shares in the marketing channels of selected agricultural commodities.

Studies were undertaken to identify diverse strategies that local food system stakeholders are currently using or might use to create and manage ongoing or potential change, and their information needs.

Research was undertaken to improve natural resources and environmental use by farmers and to support policy-making processes by government officials in order to achieve greater economic and material sustainability.

In collaboration with Extension faculty and agents, results were translated into recommendations for farmers and community organizers.

Publications were prepared and presentations made to producer associations and agricultural professionals.

2. Brief description of the target audience

Farmers, extension professionals, community leaders and organizers, producer associations, academic community, local and state government officials, and other professionals.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	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: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	7	7

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of refereed publications

Year	Actual
2014	7

Output #2

Output Measure

- Number of scientific presentations in scientific meetings

Year	Actual
2014	9

Output #3

Output Measure

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

Year	Actual

2014	6

Output #4

Output Measure

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

Year	Actual
2014	290

Output #5

Output Measure

- Number of new or improved innovations made (models, software, processes, etc.)

Year	Actual
2014	1

Output #6

Output Measure

- Number of activities/events organized (e.g., workshops, seminars, training events, educational events)

Year	Actual
2014	4

Output #7

Output Measure

- Number of research-based extension or outreach presentations

Year	Actual
2014	8

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of stakeholders gaining knowledge about public policy issues relevant to local agriculture and natural resources.
2	Number of stakeholders gaining knowledge about new information/tools (medium term measure) aimed at improving: Consumption decisions, Production management, Marketing decisions, Institutional arrangements and organizational capacities, Public policy decisions, or Natural resources and environmental management
3	Number of adopters of new or improved practices/tools in: Consumption decisions, Production management, Marketing decisions, Institutional arrangements and organizational capacities, Public policy decisions, or Natural resources and environmental management
4	Total number of participants in new market-niches generated as a result of program research

Outcome #1

1. Outcome Measures

Number of stakeholders gaining knowledge about public policy issues relevant to local agriculture and natural resources.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	50

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development
610	Domestic Policy Analysis

Outcome #2

1. Outcome Measures

Number of stakeholders gaining knowledge about new information/tools (medium term measure) aimed at improving: Consumption decisions, Production management, Marketing decisions, Institutional arrangements and organizational capacities, Public policy decisions, or Natural resources and environmental management

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1290

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
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
607	Consumer Economics
608	Community Resource Planning and Development
610	Domestic Policy Analysis
902	Administration of Projects and Programs

Outcome #3

1. Outcome Measures

Number of adopters of new or improved practices/tools in: Consumption decisions, Production management, Marketing decisions, Institutional arrangements and organizational capacities, Public policy decisions, or Natural resources and environmental management

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	5

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
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
607	Consumer Economics
608	Community Resource Planning and Development
610	Domestic Policy Analysis
902	Administration of Projects and Programs

Outcome #4

1. Outcome Measures

Total number of participants in new market-niches generated as a result of program research

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	4

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
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices
605	Natural Resource and Environmental Economics
607	Consumer Economics
608	Community Resource Planning and Development
610	Domestic Policy Analysis
902	Administration of Projects and Programs

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Government Regulations

Brief Explanation

This year, seed for a new market niche product was available in limited amount. No external funding was sought for this new market niche because it involves a tropical fruit crop; hence it has limited geographic impact. We hope this issue will not continue to be a problem as SCRI program officials, to whom we plan to submit a research proposal, have accepted considering some projects that are of local impact, following a request by a U.S. Senator from Hawaii.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Identifying and developing new market niches was deemed of strategic importance for the program, and was thus given priority in the evaluation process. Other research areas were not considered given the limited time and human resources to carry out this exercise. The

program coordinator used a focus group composed of producers adopting the new fruit crop to get insights into the nature of the audience and their needs. Emphasis was on identifying possible barriers to the adoption of this new production alternative. The information from this focus group was supplemented with input obtained in conversations with several senior researchers outside the projects in this program.

Although the program was originally conceived to give priority to major producers, a couple of highly respected senior researchers at UPR argued very strongly in favor of starting the project with small producers in mind. On the other hand, the focus group emphasized the need to make young entrepreneurs the priority, preferably those with a college degree, since they would be among the few farmers inclined to try new products and would respond favorably to a research-backed program. Both of these recommendations were incorporated in the program design for future years.

Given that young entrepreneurs and small farmers are deemed of central importance to the initial stages of the program, their probability of adopting the new fruit crop would depend on key issues being addressed, according to the focus group. These include: (1) providing technological guides and information on the nature of the economic returns of this new fruit crop, (2) providing propagation material, (3) guaranteeing sufficient genetic variability to help choose best genetic material for local conditions and consumer needs, (4) identifying financing alternatives for the initial investment needed, particularly those coming from the PR Department of Agriculture, (5) identifying incentives, such as labor subsidies by the PR Department of Agriculture, that will help pay attractive wages and thus reduce the labor shortage during the harvesting period, (6) guaranteeing the product can reach the consumer in good condition and will be accepted by consumers, and (7) developing a viable organization that channels the interests of producers of this new product. The focus group considered that the main strength of the program was introducing a new alternative to local producers. These suggestions and concerns will help shape the program in the future.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Food Safety - Food Safety, Science, Technology and Childhood Obesity (FOSSTCO)

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
501	New and Improved Food Processing Technologies			22%	
502	New and Improved Food Products			33%	
503	Quality Maintenance in Storing and Marketing Food Products			22%	
701	Nutrient Composition of Food			12%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			11%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.5	0.0
Actual Paid	0.0	0.0	1.0	0.0
Actual Volunteer	0.0	0.0	0.8	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	44038	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	33805	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The mission of the FOSTCO program is to promote the quality of life and economic viability of the agricultural sector and rural communities by continuously improving current food and non-food products, their respective manufacturing and other related processes; and developing new products. In so doing, the Program considers such aspects as food safety, nutritional value, environmental impact, needs for education and information dissemination, consumer and industry support, and technology development, transfer and adaptation.

In order to accomplish the mission, nine seminars were offered this year on the Food Safety Program. Almost twenty foods industry employees were trained in food safety and related topics (HACCP and SQF). Trainings were provided to nearly 140 farmers that produce lettuce for the School Lunch Program and for farmers of the Fresh Market Program of the Puerto Rico Department of Agriculture. The trainings focused on GAP and GMP. In an effort to help the food industry in the improvement and development of new food, we collaborated with 26 industries that contacted us for some type of collaboration. The collaboration with industry included chemical and/or microbiological analysis of food, nutritional fact analysis, and physicochemical properties of food and literature search. A project on the Impact of Current Packaging Technologies on the Quality of Minimally Processed Tropical Pumpkin was finished and the second part of the edible film project started. The second part of the project was conducted to help the food industry extend the shelf life of fresh peeled orange at a storage temperature of 55^{o}F. Production of flour using Xanthomonas spp. roots was initiated. Processing technology in flour production included: fermentation, sun-drying and cooking. The most effective method in oxalate elimination was fermentation. One poster was presented at the 2014 Annual Meeting of the Institute of Food Technology (Scientific Program).

2. Brief description of the target audience

- Extension Specialists and Agents
- Academic Programs Faculty
- Consumers
- Federal and State Agricultural Agencies (PRDA, PRDH, USDA/APHIS, USDA/ARS, FDA)
- Food Industry representatives

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	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: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	1	0

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
2014	10

Output #2

Output Measure

- Number of projects or industry collaboration agreements established

Year	Actual
2014	26

Output #3

Output Measure

- Number of people attending seminars and workshops

Year	Actual
2014	146

Output #4

Output Measure

- Amount of grant funds (internal or external) of active projects

Year	Actual
2014	18000

Output #5

Output Measure

- Number of posters and oral presentations delivered at scientific meetings.

Year	Actual
2014	3

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of improvement or development projects focused on safety or nutritional aspects of product or production processes
2	Number of projects on postharvest or packaging
3	Number of projects focusing on definition of quality parameters
4	Number of projects dealing with residues, wastes or effluents
5	Number of enterprises impacted by the Program.

Outcome #1

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Two projects are specifically targeting issues faced by growers: (1) Coffee cultivation is a way of life and the primary business for the population of the island?s central region. New strategies must be established and promoted to increase industry profits; (2) The edible part of the tanier, Xanthosoma spp., is widely used to produce products intended for human and animal consumption. However, despite its nutritional value, the corm or central root of this plant is considered a waste product due to its bitter taste and the astringency associated with high oxalate content. In order to use this plant part for flour as a raw material for developing palatable products, its oxalate content must be reduced.

What has been done
(1) A method to extract aromas of milled coffee based on the principles of vapor distillation was developed. This method made attainable a product with easily identifiable and pleasant aromas through efficient extraction and with minimum condensation of solvent over the coffee sample. GC-MS and sensory analysis were done to evaluate extracts using water and ethanol as solvents. No appreciable preference was observed in any of three formulations devised; (2)To reduce the oxalate content and to obtain tanier flour to develop products with higher palatability and stability in terms of nutrition and shelf life, three different processing methods (sun drying; fermentation for 24, 48 and 72 hours; and cooking for 40 to 60 minutes) were evaluated.

Results
(1) High quality coffee cordials and schnapps from locally harvested crops have been developed; (2) Oxalate content was reduced with the three methods; however, fermentation for 72 hours was the most efficient, achieving reduction rates as high as 77%. Flour produced from nine-month-old roots of Xanthomonas spp. is a promising raw material for elaborating different flour based products.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Number of projects on postharvest or packaging

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Consumer demand for high quality foods requiring only a minimum amount of time and effort for preparation has led to the introduction of ready-to-use, convenience foods preserved by mild methods (so-called minimal processing methods). In order to compete with consumer demand, the citrus industry of Puerto Rico produces peeled citrus oranges. This product is distributed within our island. Although there is great interest in its exportation, the short life span of the product is problematic. Researchers started to study ways to satisfy consumer demand testing different packaging techniques for minimally processed fruits.

What has been done
Research using edible film to extend the shelf life of peeled orange fruits at 55o C was conducted. In addition, a performance study of low-density polyethylene (LDPE) bags as a packaging material that could be used to maintain the quality of pumpkin pieces in storage was conducted. To verify whether minimally processed pumpkin maintains its physical, chemical, physicochemical and qualitative characteristics, sensory analyses were conducted after minimal processing.

Results

(1) The use of edible film is viable in extending the shelf life of a peeled orange. Preliminary data showed that a peeled orange coated with hydroximethyl cellulose and potassium sorbate or an edible film made of chitosan and stored at 55o C extends the shelf life of a fresh peeled orange for 14 days; (2) A sensorial panel judged pumpkin pieces stored for 20 days to be of an acceptable quality. A minimally processed product based on pumpkin treated with an antimicrobial solution, packed in LDPE bags (vacuum sealed and without vacuum) and stored for 20 days at 4° C ± 2 had safe microbiological levels and acceptable quality for the consumer.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
503	Quality Maintenance in Storing and Marketing Food Products

Outcome #3

1. Outcome Measures

Number of projects focusing on definition of quality parameters

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There are approximately 60,000 acres planted with coffee in PR. From this acreage, an estimated 54,000 produce Arabic coffee while about 6,000 acres are growing Robusta coffee. In a scientific meeting sponsored by the coffee commodity program, the current situation of the industry and research needs were discussed. Sixty percent of attendees filled out a survey indicating the need for research on attribute characterization and quality of coffee beans according to production zone.

What has been done
It is known that the quality of coffee depends on many factors such as temperature, climate and altitude. However, in Puerto Rico there is a lack of information regarding the chemical characterization of our coffee by area elevation. The chemical characterization of coffee is a useful tool to associate sensory properties of a product with specific families of compounds or molecules present. A study on the ?Chemical characterization of coffee? was conducted. This

research evaluated two varieties of coffee in two distinct areas by altitude.

Results
The results demonstrate that the effect of altitude and variety is significant, which may affect the organoleptic quality of coffee in Puerto Rico. The expected benefits associated with this research are: 1) establishment of a data bank of chemical precursors of aromas and flavors of both coffee varieties in the selected areas, 2) ability to quantify differences in terms of chemical precursors of aroma and flavors in coffee, 3) development of a tool to identify the best cultural practices for specialty coffee in addition to performance criteria.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Number of projects dealing with residues, wastes or effluents

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A decrease in fresh milk consumption has been observed due to the consumption of other types of beverages available in the market. It is necessary to offer new means to increase milk consumption in Puerto Rico and to develop a broader dairy products market. White cheese is a product very popular with Puerto Rican consumers, but the problem of disposing of the acid whey, a sub-product of cheese making, forced the industry to cease production. The whey contains 50% of milk nutrients such as protein, calcium, and other useful nutrients that could be used to expand the range of products elaborated. The whey is used in the manufacture of products, but requires some processing (dehydration and concentration) prior to its use.

What has been done

Research for the development of products with high concentration of nutrients and low fat content, using acid whey with minimal processing was proposed. The products will include yogurt, flavored milk drinks, and ?dulce de leche?.

Results
Proximal analysis for the whey, whey powder and milk was conducted. These are used in the development of different yogurt formulations. Fiber was added to the yogurt to increase nutritional value. Some of the formulations tested did not acquire the desired consistency; a taste panel did a preliminary tasting to determine consumer preferences.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products

Outcome #5

1. Outcome Measures

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
2014	26

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The island produces only 15% of the food it consumes, but these foods must be safe for the consumer. It is important that food producers and farmers understand and practice food safety procedures. Literature reports improper postharvest practices as a main contributor to product losses and deterioration in quality. Puerto Rico producers need to pay particular attention to management and handling practices after harvest if we are to seriously address food security issues.

What has been done
Different types of physical, chemical and microbiological analyses were conducted on 10 food products. In addition, nutritional facts were developed for 16 new products. Food industry representatives who requested our services did so as part of the agreement between the Food Science and Technology Program and the Puerto Rico Department of Agriculture. A total of 9

seminars were held in food safety areas such as GMP, HACCP, and GAP.

Results
Representatives from twenty-six food Industries attended. Approximately 160 food industry employees (food processors and farmers) were trained in food safety. The project on edible films provided data and experience to help the citrus industry in Puerto Rico.

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Competing Programmatic Challenges

Brief Explanation

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

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Instead of meeting, stakeholders were given a questionnaire to evaluate the program's impact and identify areas of opportunity or need. The results of the questionnaire indicate that in order to fulfill stakeholders' current and future needs, the Food Safety, Science and Technology area must do research on: 1) use of new technology or making improvements on existing technologies for processing and extending the shelf life of agricultural crops, 2) post-harvest treatment of crops, 3) new product development using the island's traditional crops as raw material, 4) quality assurance during storage and distribution of fresh produce, 5) new quality cultivars with economical potential in Puerto Rico. Stakeholders identified a new opportunity in this programmatic area to conduct research in risk assessment on possible chemical contaminants in food (including imports) sold to Puerto Rican consumers. To improve program implementation, the Program Area research must be disseminated.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Sustainable Energy - Renewable Energy Alternatives for Small Islands

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
401	Structures, Facilities, and General Purpose Farm Supplies			50%	
402	Engineering Systems and Equipment			50%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.0	0.0
Actual Paid	0.0	0.0	0.0	0.0
Actual Volunteer	0.0	0.0	0.1	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	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The two remaining research projects active in the Sustainable Energy program were completed during 2014. One of the projects proposed and established a solar energy photovoltaic system at one of PRAES substations to both reduce the high cost of electricity at its facilities, and to serve as a model for potential adopters of this technology. The system established followed an on-grid configuration using the infrastructure provided by the electric power authority, which, depending on its policies, either pays or provides credit for the power generated. The experience accumulated in the implementation of the system is being shared with stakeholders interested in the adoption of this technology in their farming operations.

The other project concluded a case-study of the technical and economical aspects involved in implementing solar energy systems in milking parlors. The study provided an analysis with which local customers, specifically from the farming sector, could establish projections and make decisions about the implementation of similar systems. A written report of the project's conclusions was submitted to the local Department of Agriculture's division of innovation and agricultural development. In addition, several presentations were delivered to government officials and interested academic faculty.

2. Brief description of the target audience

(1) Specialists and County Agents of the Agricultural Extension Service of UPR.
(2) Professional personnel of the Puerto Rican Department of Agriculture and of the USDA.
(3) Policy makers in the Commonwealth and Federal Governments.
(4) Personnel of the Farm Credit Service and other financial institutions that make loans to producers.
(5) Professionals engaged in private enterprises related to renewable energy projects.
(6) Faculty members and university graduate and undergraduate students.
(7) Farmers and managers of agroindustrial operations.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	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:	2014
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of active research projects in the program

Year	Actual
2014	2

Output #2

Output Measure

- Number of new proposals submitted targeting the program's priorities

Year	Actual
2014	0

Output #3

Output Measure

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

Year	Actual
2014	1

Output #4

Output Measure

- Number of meetings held with stakeholders to extend results and technologies

Year	Actual
2014	2

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of participants in meetings held with stakeholders to extend project's results and technologies devised
2	Number of government agencies and other type of institutions willing to collaborate in projects promoting energy efficiency and renewable energy technologies
3	Number of farmers or agroindustrial operations becoming more energy efficient and adopting renewable energy alternatives

Outcome #1

1. Outcome Measures

Number of participants in meetings held with stakeholders to extend project's results and technologies devised

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	55

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #2

1. Outcome Measures

Number of government agencies and other type of institutions willing to collaborate in projects promoting energy efficiency and renewable energy technologies

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

Outcome #3

1. Outcome Measures

Number of farmers or agroindustrial operations becoming more energy efficient and adopting renewable energy alternatives

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes

Brief Explanation

This program was created four years ago. Only a few projects were active in this area and the time commitment of researchers to them was relatively small.

Availability of continued funding for research and for incentives for public adoption of technologies is vital for achieving progress in this program. The recession and increasing cost of inputs may limit farmers' ability to adopt technologies with long-term payoffs.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

An evaluation of the implementation process of this program was conducted in November 2013 and reported in last year's annual report. The following comments offered by participants in an online survey of faculty interested in the program offer insights on both the strengths and limitations of these initial years of the program:

- Respondents remarked that it would be hard to implement some of these projects when little funding is available.
- Nevertheless, some believed we now have two good case studies on energy that can be showcased in upcoming years and can be used for evaluating the program's success.
- This program, as well as many others, is limited to researchers in the field that are willing to undertake research that could lead to energy savings on farms. More expertise is needed within the CAS in this area.
- The program activities should have closer ties with extension and farmers so that a participatory research approach can be implemented.

The current integration of research and extension in our combined Plan of Work may facilitate the implementation of new initiatives in sustainable energy but in the near future only extension faculty will be conducting work in this program.

Key Items of Evaluation

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.