2019 Annual Report of Accomplishments And Results (AREERA)

[Puerto Rico]
[University of Puerto Rico Agricultural Experiment Station]
[University of Puerto Rico Agricultural Extension Service]

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your Plan of Work. Use this space to provide updates to your state or institutions as needed.

1. Executive Summary (Optional)

This annual report combines what the University of Puerto Rico's Agricultural Experiment Station (PRAEXS) and Agricultural Extension Service (PRAES) consider to be our most salient achievements in research and education during FY2018-19. Puerto Rico continues recovering from Hurricane María that impacted tremendously all aspects of life in the island. Among the most damaging effects are massive emigration (over 250,000 of people), long power outages (months), shortages of drinking water, educational and social instability, and agricultural losses surpassing the $780 million, according to the Department of Agriculture.

As reported, important research and extension activities took place last year that benefited farmers, communities and other stakeholders that are still slowly recovering from the devastation suffered from the 2017 hurricanes, Irma and María. This progress was achieved while facing the challenges of rebuilding the damage suffered in vital infrastructure facilities, and while researchers often had to restart experiments and data collection lost during the storms. All this was framed in the context of

an overall worsening economic situation that significantly affected the budget assigned to the state university. Sad to say, at that time we couldn't imagine that our future outlook would be further complicated by the 2020 earthquakes and worldwide pandemic that has already left 38% of our population unemployed. Lessons learned from previous disasters had to be quickly put into practice under a transformed reality that has changed our usual way of conducting business and meeting our goals.

Following initial instructions, we are reporting accomplishments and results from most of the eleven programs planned in the last POW, prepared before the two-year moratorium implemented by NIFA in 2017. In this introduction, however, for the sake of brevity we have organized the review of our most outstanding activities under the new "Critical Issues" defined in last year's plan of work.

The current **"Food security, plants and animal systems**" critical issue includes the work previously performed under the programs titled "Plant Production Systems, Genetic Resources and Breeding", "Animal systems", Integrated Management of New and Emerging Pests and Diseases" and "Global Food Security and Hunger". Practically all of our research and extension activities directly related to farming are now classified under this new label and issue-description.

As the 2019 POW suggested, our work continues to emphasize research and extension efforts that address the most important production constraints faced by our stakeholders. Through new micropropagation techniques such as the Temporary Immersion Bioreactor system (TIB) outlined in accomplishment #2, the production of disease-free seeds and planting materials for selected roots and tubers can now be expanded at a lower cost, while the extension-led evaluation of new hydroponic technology to multiply healthy coffee trees (activity #3) also resulted in the production of healthy seedlings in a shorter period and with lower cost per unit. Along with the research efforts, courses on sustainable management (n=188), IPM practices (n=43) and total trained people (n= 1,146), more than 100 farmers have adopted recommended management practices that increase the efficiency of production of coffee. The diffusion of research products and the adoption of

recommended practices is helping advance the replanting of coffee plantations devastated by the 2017 hurricanes.

The availability of disease-resistant cultivars of grains, vegetables and other traditional food crops is one pillar of ongoing efforts to increase the food security situation of Puerto Rico. The liberation of new varieties of beans that combine resistance to the most common diseases of this crop remains an important cooperative achievement of researchers in the island and in the US supported by Hatch funds (accomplishment #1). Farmer demand for these seeds during this critical period continued to surpass PRAEXS limited for-sale supply.

The development of citrus greening (CG) control practices adapted to our local conditions, and of an educational program to disseminate research results and management options, was also an important research and extension priority in our 2019 POW. As portrayed in accomplishment #10, the maintenance of disease-free citrus varieties and planting materials at the PRAEXS substations, along with continued variety trials, testing at nurseries, and PRAES best management practices trainings and demonstrations, has served as a cornerstone of the approach devised for the control of the disease, in coordination with the Department of Agriculture. Through the successful operation of our Plant Diagnostic and Disease clinics (accomplishment #11) the surveillance and monitoring of our current crops have continued and integrated management practices have been developed for the control of pests such as the Banana Rust thrips (accomplishment #12). PRAES continues providing training and farm visits to educate our farmers in topics related to business management, marketing and IPM practices. With the help of the PRAES Plant Clinic Diagnostic Service, Extension Agents provide more accurate recommendations to our crop producers.

Due to the vulnerable food supply chain of Puerto Rico, the PRAES continues to promote the restoration of local crop production as a means to increase food security (accomplishment #5). Strategies to increase food production are focused on empowering small farmers' and communities' knowledge through outreach. Home Gardens, School Gardens and Community Gardens are among the most common initiatives that PRAES have fostered to encourage people to produce their own

fresh food, with some of the most relevant achievements presented in accomplishment # 24. Other PRAES activities to promote food security in Puerto Rico include a collaboration with the Center of Disaster Philanthropy that aimed to train farmers and communities about crops with short-term harvesting potential, marketing strategies to improve sales, farm administration tools, natural conservation practices, and food safety and food preservation methods (e.g., food canning), as a resilience approach towards events that compromise food security.

In terms of **Animal systems**, several approaches were implemented by PRAES and PRAEXS to help farmers recover and to promote food production. Intensive training about production of freshwater fish through Aquaponics was one of the approaches adopted to help our audience to produce food in a short time period and in a sustainable way. Fort-six (46) participants completed the Aquaponics course.

Increasing the efficiency of dairy cattle production continues to be a priority to PRAEXS and PRAES with the generation of outreach activities and research products. Among these, the first Interdisciplinary and Multi University Agro-Innovation challenge was performed at the UPRM. In this combined PRAES/PRAEXS effort, students created prototypes to help tackle the list of needs collected in stakeholder meetings with dairy farmers. This project generated intellectual property procedures associated to a novel cow bedding system devised (accomplishment # 8), that further allowed the students to compete and win at the UPRM NSF I-corps, permitting them to travel to the USA to improve their knowledge of dairy cattle.

Heat stress continues to hinder production efficiency of dairy herds. Many outreach and research efforts have been undertaken to overcome this, including combined efforts to better characterize our slick Holstein cows. The best known efforts are detailed in the Planned Program Activities and Accomplishments section, including the description of an important Collaborative Agreement reached with the Puerto Rico Department of Agriculture (accomplishment #6). A total of $750,000 was granted to PRAEXS/PRAES to establish an advanced reproduction laboratory for the production and evaluation of slick Holstein cattle.

After the 2017 hurricanes many young people became interested in agriculture, including the production of small ruminants. Since then, PRAEXS and PRAES through research and outreach promoted management practices that increase production efficiency in tropical areas. In addition, several research trials have evaluated the effect of various management practices on meat quality and on the reproduction of goats and sheep (Accomplishment #7).

The current **"Extreme Weather, Natural Resources and Environment, and Sustainable Energy"** critical issue combines our former separate programs focused on these topics and on climate change. After the 2017 hurricanes, forestry research and extension initiatives gained more prominence in our programs given the increased need to find profitable ways to reuse and recycle huge quantities of biomass wastes, and the prospective contributions that "novel" forests could provide in support of food production (accomplishment #13). Research and educational efforts in soil quality and soil management, important for climate change mitigation and adaptation, have also been expanded through the establishment of soil quality experiments and through the retraining of agricultural agents in these topics (activity #14).

Our **Food Safety, Science and Technology program**, defined in the equally titled current critical issue, continues to integrate the extension goal of targeting individuals and the food industry sector to adopt food safety handling practices (activity #16), with research in the food science technologies that develop new, added-value, and safe food products. The creation of value-added products from local farinaceous crops is part of ongoing research efforts to increase the island's food security (accomplishment #15).

Under the **Community, Economy and Sustainable Development** critical issue (formerly titled "Community Resources for Sustainable Development, Agricultural Economics, Marketing and Added Value") PRAES and PRAEXS continue to offer a joint socioeconomic perspective on the major problems affecting farming and communities in Puerto Rico, and the research/extension-oriented alternatives advanced to address them. Studies that can help stakeholders identify profitable market

niches for their products were undertaken and consumer's willingness to pay for differentiated milk and coffee products was estimated (accomplishment #18). In addition, trainings of volunteer leaders and community members on Extension's curriculum for strengthening community leadership and on promoting family and community financial strength were delivered (activities #19 y #20).

The **Family and Well-Being** component continues to promote healthy behaviors, disease prevention, and family resources management to improve the quality of life of our vulnerable populations. Our health component focused on disease prevention of chronic and infectious diseases and prevention interventions. Since the Hurricane María in 2017, recovery efforts have been slowly flourishing. The island was already in an economic recession where almost half of the families lived at or below the federal poverty level. Poverty is known to have a negative impact on vulnerable individuals such as children, teenagers and the elderly.

The Family and Well-Being program continues attending to health disparity issues and support socially disadvantaged families through education on topics related to health and hygiene. As part of these efforts, a total of 1,104 participants acquired knowledge about healthy lifestyles, resulting in behavioral changes such as incorporation of physical activities and regular monitoring of blood sugar and cholesterol levels (n=585 participants). More detailed examples are presented in accomplishment # 22.

The PRAES **Positive Youth** critical issue now covers our work under the formerly titled "Strengthening Youth Life Skills, Leadership and their Community**"** Educational Program. It continues creating safe learning spaces, establishing positive contacts and providing opportunities and experiences for children and youth to develop skills and abilities to become healthy individuals that positively contribute to our society. These include the engagement of voluntary youth leaders to expand and improve our activities, intensification of extracurricular activities such as internships and clubs focused in promoting emotional support for youth, and reinforcement of efficient coping mechanisms before, during and after natural disasters and emergencies. All these efforts have

resulted in the impacting of more than 15,000 youth participant throughout the island, with some of the most relevant achievements presented in Accomplishment # 23.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Process	Updates
1. The Merit Review Process	The Extension Merit Review process continues to be conducted through four committees representing each of the four major program areas: Agriculture, Marketing and Natural Resources; Family and Consumer Sciences; 4-H and Youth Development; and Community Resource Development. Each committee is composed by a minimum of five members that include: Internal University members (the program leader, two specialists (one from the Planning and Evaluation Office and one from the major subject areas), a researcher from PRAEXS and other faculty members, and external Non-University members (e.g., representatives of the major government agencies or organizations that work with similar audiences). External Members from different committees include representatives from government agencies at the regional or state level, such as: The Department of Family, Department of Education, Department of Agriculture, Mayor's Office, Governor's Office for Youth Issues, Rural Development Corporation, the Farmers' Association, Farm Service Agency, Consumer Department, Head Start, Police Department, as well as representatives from nongovernmental organizations, the religious sector and the private sector, among others. Each committee meets at least twice during the current fiscal year to evaluate the proposed plan of work.

	External committee members evaluate the quality and relevance of the activities and programs of the State goals and offer recommendations in concordance with the PRAES critical areas. A written report is prepared at the end of each fiscal year by the program leader, in accordance with the committee members. The report is presented to the Merit Review committee describing how the committee's recommendations will be addressed and incorporated in the Plan of Work.
2. The Scientific Peer Review Process	An annual call for proposals which includes the year's revised research priorities is prepared and distributed by the recently integrated Research and Sponsored Programs Office. This new office combines research and externally funded activities for both the Agricultural Experiment Station and the Agricultural Extension Service. Proposals are submitted to the Assistant Dean for Research with the preliminary endorsement of the respective Department Head. The Assistant Dean for Research sends the proposal to a local peer reviewer and an external reviewer for their written comments on the scientific merit of the proposed research and compliance with the PRAEXS strategic plan. Reviewers are instructed to use a template which specifies the evaluation criteria and their value. Among other criteria, reviewers must assess the technical competence of the proposals and their feasibility (i.e., the capacity of the Principal Investigator and his team to carry out the research objectives). Proposals and their reviewers' input are discussed and evaluated by the CAS Associate and Assistant Deans for Research, and a final decision is taken by the administration.

III. Stakeholder Input

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Stakeholder Input Aspects	Updates
1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation	No significant updates to what was stated in our 2021-2025 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2021-2025).
2. Methods to identify individuals and groups and brief explanation.	No significant updates to what was stated in our 2021-2025 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2021-2025).
3. Methods for collecting stakeholder input and brief explanation.	No significant updates to what was stated in our 2021-2025 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2021-2025).
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	No significant updates to what was stated in our 2021-2025 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2021-2025).

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IV. Planned Program Table of Contents

V. Planned Program Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). See Section V of the Guidance for information on what to include in the qualitative outcomes or impact statements. Add additional rows to convey additional accomplishments. You may expand each row as needed.

No.	Title or Activity Description	Outcome/Impact Statement	Planned Program Name/No.

1.	Breeding dry bean varieties (*Phaseolus vulgaris* L.) with enhanced nutritional value and resistance to the most common diseases	**What is the issue?** *Phaseolus vulgaris* L. is an important crop in the United States (U.S.) with a one-billion-dollar farm gate value and is the most important pulse crop worldwide. Fungal, bacterial, and viral diseases are among the main production constraints, while extreme weather events, soil mineral deficiencies, and short growing seasons reduce productivity. It is essential for common bean sustainability to improve bean yield potential by incorporating resistance/tolerance to major biotic and abiotic stresses, broadening the genetic base, and developing genomic resources. Identifying and implementing sustainable agricultural systems that improve bean seed yield, conserve natural resources, and protect the environment are also within the scope of our work. **Target audience** Farmers in Puerto Rico who use improved bean cultivars developed by UPR bean breeders. The scientific community that learns about results through the project's publications and presentations at scientific meetings. **What has been done?** A white bean line that combines resistance to Bean golden yellow mosaic virus (BGYMV), Bean common mosaic virus (BCMV), and Bean common mosaic necrosis virus (BCMNV) and common bacterial blight (CBB) was released as 'Bella'. The black bean line PR1147-1 that combines resistance to BGYMV, BCMV, CBB, web blight with superior performance in low N soils was released as 'Hermosa'. Seed of bean varieties	*1. Global Food Security - Plant Production Systems, Genetic Resources and Breeding Program*

		developed with the support of Hatch funds and released by the UPR Agricultural Experiment Station is offered for sale to farmers at the Isabela Substation. Seed production fields demonstrate the application of Best Management Practices for beans. The Agricultural Extension Service offered an integrated grain and legume management course in which two trained producers benefited. The producers adopted more than two techniques of integrated management strategies for grains and legumes, and subsequently informed us that they increased the size of their agricultural business, reduced the use of pesticides and increased farm production. During the past five years, as a cooperative activity of Regional Hatch Project W-3150, the PRAEXS has planted > 20,000 bean breeding lines from Michigan State University, the University of Nebraska and North Dakota State University in winter nurseries, expanding the impact of our work to audiences outside the island. **Results** The white bean line released as "Bella", with resistance to BGYMV, BCMV, BCMNV and common bacterial blight (CBB), also demonstrated superior performance in low-N trials conducted at Isabela, Puerto Rico. The black bean line released as 'Hermosa' is the first release of a black bean cultivar for Puerto Rico. Although endemic isolates of the angular leaf spot pathogen have been found to have high	

		levels of virulence, white bean breeding lines with resistance were identified. Six lines were identified that had less severe ashy stem blight symptoms when inoculated with a *Macrophomina phaseolina* isolate from Juana Diaz, Puerto Rico. The white bean cultivar 'Verano' and the light red kidney bean cultivar 'Badillo' were resistant to *Xanthomonas axonopodis pv. phaseoli* and *Xanthomonas fuscans* isolates from different seed sources. Four bean lines were identified to have resistance to a *Fusarium solani* isolate from Isabela, Puerto Rico. Common bean lines were identified that can be used to identify different pathotypes of the common bacterial blight pathogen. Also, an updated Bean Technology Package was prepared that provides a set of recommendations for the production of beans in Puerto Rico tailored to different scales of production. **External Factors (optional).** Farmers and researchers in Puerto Rico faced serious challenges during the past five years. Hurricane Maria in September 2017 caused field and laboratory research to be postponed for almost six months. The hurricane was followed by a drought and reduced availability of water for irrigation. During the current fiscal year, the COVID-19 pandemic has caused a significant disruption of proposed research activities. **Other information:**	

		The Technology Package for Beans will soon be published on the UPR Agricultural Experiment Station website (https://www.uprm.edu/eea/publicaciones/) Publications: Abbasabadi A.O., T. Porch, J. Rosas, S.M. Moghahdam, J. Beaver, S. Beebe, J. Burridge, C. Joshua, M. Miguel, P. Miklas, B. Ratz, J. White, J. Lynch and P. McClean. 2019. Single and multi-trait GWAS identify genetic factors associated with production traits in common bean under abiotic stress environments. G3: Genes/Genomes/Genetics 9(6):1881-1892. Beaver, J.S., T.G. Porch, G.L. Vázquez, A. González and C. Estevez de Jensen. 2019. Performance of Mesoamerican beans in a low fertility soil. Ann. Rep. Bean Improv. Coop. 62:91-92. Beaver, J.S., C. Estévez de Jensen, L. Ruiz Quiles, G. Vázquez, A. González, H. Martínez and T.G. Porch. 2018. Release of 'Hermosa' black bean cultivar. J. Agric. Univ. Puerto Rico 102:123-128. Rosas, J.C., J.S. Beaver, C. Estevez de Jensen, A. González, D. Rocha Clavijo and R. Macchiavelli. 2018. Field evaluation of common bean for reaction to web blight and high temperature. J. Agric. Univ. Puerto Rico 102:113-121. De Ron, A.M., V. (K.) Kalavacharla, S. Álvarez-García, P.A. Casquero, G. Carro-Huelga, S. Gutiérrez, A. Lorenzana, S.	

		Mayo-Prieto, A. Rodríguez-González, V. Suárez-Villanueva, A. P. Rodiño, J.S. Beaver, T. Porch, M. Z. Galván, M.C. Gonçalves Vidigal, M. Dworkin, A. Bedmar Villanueva and L. De la Rosa. 2019. Common bean genetics, breeding, and genomics for adaptation to changing to new agro-environmental conditions p. 1-106. *In* Genomic designing of climate-smart pulse crops. Chittaranjan Kole (ed.). Springer, New York, NY. Strock, C., J. Burridge, A. Massas, J. Beaver, S. Camilo, D. Fourie, C. Jochua, M. Miguel, P.N. Miklas, E. Mndolwa, S. Nchimbi-Msolla, T.G. Porch, J. Rosas, J. Trapp, S. Beebe, J. Lynch. 2019. Seedling root architecture and its relationsith seed yield across diverse environments in *Phaseolus vulgaris*. Field Crops Research 237:53-64. Kamfwa, K., J.S. Beaver, K.A. Cichy and J.D. Kelly. 2018. QTL Mapping of Resistance to Bean Weevil in Common Bean. Crop Sci. 58:2370-2378	

2.	Helping Arracacha farmers in the central region of Puerto Rico to increase their yields and income through disease-free propagation material and better soil fertility manage-ment practices	**What is the issue:** A strategy to increase competitiveness of disadvantaged small farmers in mountain regions is to produce specialty crops specifically adapted to upland conditions, with enough market demand and farm gate value to compensate for the higher production costs of upland agriculture. One such crop is Arracacha (Arracacha xanthorriza bancroft), which originates from the Andes and in Puerto Rico yields well at altitudes above 600 m. Well managed crops can yield in excess of > 20 tons/ha, generating farm gate prices generally > $1,000/ton. Arracacha is a good source of minerals and vitamins, used in baby and hospital foods because of a unique complex of starches, oils and mineral salts that confer high digestibility. Demand for this tuber is high but poorly covered in Puerto Rico. The crop must be propagated vegetatively by suckers or tubers, a system that allows build-up of diseases. More planting material is needed, especially disease-free material, as well as information on soil test criteria for soil fertility management and crop response to liming in acid soils. **Target audience** Root and tubers producers, Arracacha farmers in municipalities of Puerto Rico's central mountain region. Agricultural Extension Service agents working with Arracacha farmers. **What has been done?** A protocol for the propagation and production of clean Arracacha seeds was developed using a relatively new	*1. Global Food Security - Plant Production Systems, Genetic Resources and Breeding Program*

		micropropagation technique, the Temporary Immersion Bioreactor system (TIB). This technique can provide high yields of high-quality propagules in a liquid media with reduced labor and space requirements. Compared to conventional micropropagation in solid media, this system can provide rapid and efficient plant propagation with lower production costs. A survey of management practices and problems encountered by ten Arracacha farmers in Puerto Rico's central region was conducted. Detailed soil and tissue samplings were taken collected from of Arracacha plantings on the order of 6 months old on six farms in the area. Tissue sample results indicated possible Mg and Mo deficiencies. A micronutrient application trial was established on one of the farms where probable Mo deficiency had been identified. Three lime-response experiments were established: one on a farmer's field in Barranquitas, one in a greenhouse pot experiment at the Río Piedras research Center of UPR-ARS, and one at the Adjuntas Agricultural Experiment Station. The amount of calcium carbonate applied in the different liming treatments were various multiples of soil exchangeable Al levels, with the purpose of obtaining soil pH values ranging from less than 5.5 to above 7. Two of the experiments (Barranquitas farm trial and Río Piedras greenhouse experiment) were harvested.	

		Results The TIBs system proved suitable to propagate and produce clean seeds of Arracacha. Improving the *in-vitro* multiplication rate using the TIB system is important to maximize the production of disease-free propagation material for farmers. Soil test results from the sampled farms in the island's central region yielded pH values of 6.5 or higher on most farms, indicating that over-liming may be causing problems. Most farmers confirmed that approximately every two years, they applied several tons of lime per acre, regardless of current soil pH. No difference in plant development was observed. However, in the micronutrient application trial between the plots with and without micronutrient treatments, both of the harvested experiments showed that Arracacha responds positively to liming in acid soils with pH<5.5 but responds negatively to liming at pH values > 6.5. These research activities and results represent a first step in the process of helping Arracacha farmers to improve their yields and income by reducing yield losses generated by contaminated planting material, and also by incorporating better soil fertility management practices. **External Factors** Laboratories at the Agricultural Experiment Stations of Rio Piedras and Isabela were without electricity for more than three months after Hurricane Maria delaying the progress of	

		work in the production of disease-free and genetically stable planting material for farmers. Hurricane Maria also delayed the planting of a third liming experiment and its harvest, limiting the results available at the time of this report. **Publications** Cevallos-Hidalgo, P. A. 2019. Valoración de prácticas culturales para el control de la pudrición del cormo, producción a escala de material de propagación libre de enfermedades y estimación de la diversidad genética de apio (*Arracacia xanthorrhiza* bancroft) en Puerto Rico. University of Puerto Rico, Mayaguez campus.	

3.	Boosting coffee seedlings with hydroponic technology to Improve coffee quality and increase its production.	**What is the issue?** Hurricane Maria destroyed 90 percent of all coffee trees on the island. Most small-scale specialty coffee farmers lost their business operations. In order to start a new operation, new trees need to be planted. A grower can take from 9 to 12 months to produce new trees, and sometimes they are produced with defects that are not visible until one year after planting, causing losses in planting maintenance and delayed fruit production. **Target audience** Small scale specialty coffee growers **What has been done?** An Extension agent in collaboration with a doctorate student from the University of Hawaii established a field validation project on two farms located in the mountain region. They established a greenhouse operation to test soluble fertilizers with new seeds in pipes with soilless potting mix and monitored the trees and water quality for four months. The producer was trained by the Extension agent and successfully produced 20,000 healthy young trees in half the time compared to traditional methods. **Results** For a 100-acre farm, the grower was able to produce healthy seedlings in a sustainable way in a shorter period of time and saved over 83% of the cost per unit. This initiative was also adopted by the PR Department of Agriculture that coordinated	1. Global Food Security - Plant Production Systems, Genetic Resources and Breeding Program

		training for many specialty coffee producers and established a pilot program using this method, planting more than 50,000 new trees to increase sustainable coffee production. Educational activities carried out included training for 268 coffee growers and 86 agronomists. Workshops, educational exhibitions and demonstrations reached 1,900 participants. Two publications, 13 newspaper and online articles on practices for the production and marketing of specialty high quality coffee from seed to cup were completed. **Other information:** Caraballo, E. 2019. Boosting coffee seedlings with hydroponic technology. *SEA del Oeste (5), 3*8-39. https://www.uprm.edu/sea/mdocs-posts/sea-del-oeste-vol-3-2019/ https://www.uprm.edu/cafe/	

4.	Sustain-able Vegetable Production	**What is the issue** Commercial vegetables are grown year-round in Puerto Rico's open fields at different geographical locations, and growers have constantly used synthetic agrochemicals to enhance yields to maintain competitiveness. This constant use has caused soil erosion, reduced soil health and fertility, impacted biodiversity and agricultural sustainability and possibly hindered future production. For this reason, a team of extensionists and researchers collaborated on different projects with growers to evaluate alternative management strategies that included the use of organic amendments such as compost, cover crops and the use of biological inoculants to maximize yield in a sustainable way. **Target audience** Vegetable growers, Extension educators, agronomists, and the private and public compost industry benefited from workshops, courses, field demonstrations and educational materials. **What has been done?** Two projects evaluated sustainable practices of growing vegetables at different geographical locations. In one study, an experiment was conducted for two years in an organic field and a conventional field to evaluate the combined effect of cover crops incorporated as green manure, the use of microbial inoculants, and resistant varieties on insect pests, diseases, nutrient availability and yield of tomato and peppers grown in the western (Lajas) and southern (Juana Diaz)	1. Global Food Security - Plant Production Systems, Genetic Resources and Breeding Program

		regions. The second study included field validations in three regions to demonstrate the effectiveness of available organic nutrient sources such as compost that can provide enough nutrients to vegetables production while suppressing important pests and minimizing environmental issues. The project aimed to find ways to make appropriate calculations of compost as a soil amendment that can minimize production costs and negative environmental impact, and to transfer this information effectively to growers. **Results** Appropriate sustainable strategies and programs were developed on various important vegetable crops for different geographical regions. Extensionists, researchers and graduate students have been disseminating information via national conferences, local TV shows, field days, workshops, webinars, and courses. In addition, many educational materials have been developed (factsheets, handbooks and videos). These materials are available on social media and on a web page under the name Empresa de Hortalizas UPRM on the official PRAES website. Also, the efforts of the Agricultural Experiment Station at Juana Diaz led to establishing a new facility for the Research and Extension Sustainable Vegetable Crops Program. Establishing research plots was also part of a mentoring program for several undergraduate students from The Biotechnology and Agrobiotechnology Teaching and Research Center of the Pontifical Catholic University of Puerto Rico in collaboration with the UPRM to encourage careers in food	

		security. Furthermore, from informal courses offered by Extension personnel, 258 vegetable producers adopted more than two techniques of integrated crop management, while 79 growers adopted sustainable practices on their farms and four growers established new organic farms implementing such strategies. **Other information:** https://sites.google.com/a/upr.edu/hortalizas/home https://www.facebook.com/pg/empresadehortalizasuprm/posts/ https://www.youtube.com/channel/UCBdFstWWQiN4p346Ot4xbeg Hernandez, E., J. Chong and D. Bair. 2020. Manual de Composta para la Producción de Hortalizas a Pequeña Escala. Universidad de Puerto Rico. MEI SEA. pp19. Hernandez, E., and J. Chong. 2018. The Effectiveness of Organic Amendments in the Production of Vegetables in two Regions of Puerto Rico. Proceedings of Annual Meeting SOPCA. p38. Hernandez, E., B. Brunner and J. O'Hallorans. 2018. Evaluating Cover Crops and Rhizobacteria on Different Sweet Pepper Varieties to Maximize Fruit Yield in a Semi-Arid Region of Puerto Rico. HortScience 53(9) Supplement. s383. https://doi.org/10.21273/HORTSCI.53.9S.S1	

		Crespo, D., E. Hernandez, B. Brunner and J. O'Hallorans. 2018. Sustainable Strategy for Integrated Crop Management in the Conventional and Organic Production of Tomato in Puerto Rico. SEA del Oeste Supplement. p71. http://www.uprm.edu/cms/index.php?a=file&fid=15186 Hernandez, E. 2018. Revitalizing Puerto Rico Towards Sustainable Vegetable Production. Scientia Global. https://doi.org/10.26320/SCIENTIA198 Hernandez, E. and B. Brunner. 2017. Tomate de Ensalada. Factsheet Hort-04-17. UPRM-SEA. Hernandez, E. 2017. Brócoli y Repollo. Factsheet Hort-01-17. UPRM-SEA. http://agricultura.uprm.edu/cms/index.php?a=file&fid=15746	

5.	*Increased food availability by enhancing local production of agricultural products*	**What is the issue?** Each year, Puerto Rico loses its best productive farm land, increasing scarcity of agricultural products for local consumption and reducing its contribution to the global food market. The consequence is that food imports have exceeded eighty percent (80%) of the food products consumed on the Island. This is the main reason why the food security of Puerto Rico is extremely vulnerable. Our main supplier is the USA and food transported to Puerto Rico travels more than 2,800 miles. More worrisome is the fact that cargo ships carrying our food have to cross the Caribbean Hurricane Zone, increasing even more our food security vulnerability. We need to increase local food production and also prevent the dissemination of crop diseases in order to increase our food security. **Target audience** Farmers, Farmers Stakeholders and Extension County Agents **What has been done?** PRAES county agents and specialists provided individual assistance and training to farmers on topics related to crop production, sustainable agricultural practices, farm management, feasibility analysis and marketing networks. A total of 26 courses on integrated pest management practices (IPM) were conducted to accomplish this goal. **Results**	1. Global Food Security - Plant Production Systems, Genetic Resources and Breeding Program

		From the participating audience, 51 farmers prepared a Business Plan after obtaining training on feasibility analysis; 237 farmers acquired agricultural loans and grants and 2,843 acres were managed under conservation practices. Additionally, 135 new farms were established, and 262 farmers increased their business size while 954 farmers increased their production level. A total of 359 PRAES participants were trained in the use and application of practices related to IPM through 26 courses conducted throughout the island. From these 359 participants, 118 farmers adopted IPM practices in their farms; 61 improved their production by implementing the recommendations offered. It was also reported that 65 plantain producers adopted 1 or more recommended practices for the management of black Sigatoka, 29 citrus producers adopted IPM practices for the control of Citrus Greening and 33 farmers implemented recommended practices after receiving recommendations from the PRAES Plant Clinic Diagnostic Service.	

6.	Puerto Rican slick Holstein cattle: a strategy to improve milk production and reproductive performance in tropical and subtropical environments.	**What is the issue?** Heat tolerant dairy cattle that can tolerate warmer climates and perform more efficiently demand prompt attention. A slick hair gene appears to be an adaptation of cattle to heat stress. Improving knowledge of the Puerto Rican slick-haired Holstein will be important for precise selection of animals, and subsequent increase in efficiency of milk production and reproduction on dairy farms in tropical and subtropical areas. **Target audience** Dairy Farmers, Agricultural Extension Service Specialists, County Agents, and forage producers. **What has been done?** Studies on genes associated with thermoregulation, comparative microanatomy of skin samples from slick and normal haired cows, and growth and health of slick calves have been conducted. Additional experiments to evaluate feed efficiency and feeding systems in slick haired cows were also performed and experiments with slick haired bulls and calves are in progress. Three stakeholder meetings, held throughout the island, were attended by 125 participants and; results of the work done on dairy cattle were presented. Additionally, 23 dairy farmers were trained in management and genetic strategies to reduce heat stress in dairy cattle. **Results**	2. Animal systems

		Field studies suggest that slick-haired cows better withstand tropical environmental conditions than their normal haired counterparts. Greater areas of sweat glands and wider sebaceous glands were also observed in the skin of slick-haired cows when compared to their wild type Holstein counterparts. Expression of genes of economical relevance did not differ between slick and normal hair Holsteins, suggesting that additional studies are needed to better understand the differences observed in reproduction, milk yields and thermoregulation. Different grass and legumes species in slick hair cattle diets were evaluated with great success. In collaboration with the Puerto Rico Department of Agriculture, the first laboratory for the evaluation and reproduction of Holstein slick haired cattle is being developed at the Gurabo Agricultural Experiment Substation to help farmers increase their productive efficiency in tropical and subtropical dairy farms. Other information such as relevant websites is optional A total of 6 abstracts were presented at national meetings. https://www.researchgate.net/publication/337705325_MEMORIAS_SOPCA_2019 Five journal articles were published at the Journal of Agriculture of the University of Puerto Rico. https://doi.org/10.46429/jaupr.v103i1.17900 https://doi.org/10.46429/jaupr.v103i1.17901 https://doi.org/10.46429/jaupr.v103i1.17902 https://doi.org/10.46429/jaupr.v103i1.17906	

		Two abstracts were presented at Animal Dairy Science Association 1. Rectal temperature, respiration rate, and heart rate of slick-hair and wild- type lactating Holstein cows under heat stress 2. Feed efficiency of slick-hair and wild-type dairy cows under heat stress Puerto Rico Department of Agriculture collaboration press release https://waloradio.com/avanza-la-reproduccion-de-vacas-con-mayor-produccion-de-leche-en-gurabo/	

7.	Enhancing production systems for small ruminants raised in the tropics	**What is the issue?** In tropical environments, heat stress negatively affects animal's productive and reproductive performance. Therefore, nutritional and management strategies to decrease heat stress and enhance productivity are essential for lamb and goat producers in Puerto Rico. **Target audience** Members of the Puerto Rico Department of Agriculture Small Ruminant Production Fund and independent sheep and goat producers make up the main target audience of the project. **What has been done?** Different research trials about the effect of different energy densities in diets on growth, carcass characteristics and meat quality of lambs raised under heat stress have been conducted. Reproduction trials to evaluate ram semen quality and the effect of the length of the breeding season on ewe reproductive performance have been evaluated. Outreach activities involving the participation of 200 people that were trained on implementation of alternative crops/forages to improve the use of nutrients in livestock production; nutrition, reproduction, health, parasite control as well as record keeping to improve production efficiency in goats and sheep under tropical conditions were performed. **Results** Research results have shown that semen quantity and quality of rams raised under heat stress conditions were affected by	2. Animal systems

		season of the year and time (am or pm) of the day. Reproductive performance of ewes raised under heat stress was similar in short or long breeding seasons (34 versus 51 d). Lamb carcass characteristics, cut yield, and meat quality was not affected when fed two total digestible nutrient levels. From the 200 people trained: · 17 reported increasing herd productivity and 12 increased the size of their herd · 6 adopted practices for the protection and welfare of their animals and 22 implemented internal parasite control protocols · 24 goat producers implemented alternative crops/forages to improve nutrient utilization · 8 adopted recommended reproduction practices in their herd **Other information:** Seven abstracts were presented at regional or international meetings and one journal article was published in the Journal of Agriculture of the University of Puerto Rico. Three master's thesis projects are presented at the University of Puerto Rico graduate school web page. https://scholar.uprm.edu/bitstream/handle/20.500.11801/2485/CIAN_SuarezRodriguezJI_2019.pdf?sequence=1&isAllowed=n https://scholar.uprm.edu/bitstream/handle/20.500.11801/2535/CIAM_RosadoHuertasJ_2019?sequence=1&isAllowed=y	

		https://scholar.uprm.edu/bitstream/handle/20.500.11801/1828/CIAN_BenabeCarloE_2018.pdf?sequence=1&isAllowed=y Two field-days, one on feeding systems for small ruminants and the other on lamb carcass characteristics, cuts, and meat quality were conducted with 46 producers participating.	

8.	Turning dairy farm challenges into opportunities for students: The Dairy-Innovation Challenge	**What is the issue?** A dairy herd is characterized by many agricultural components that depend on technology and innovation to be cost-effective. Most of the technologies adopted by our farmers come from outside of Puerto Rico, sometimes making their accessibility challenging or even impossible, especially to small dairy farmers. Current technologies adopted by our farmers could be improved by incorporating innovative adaptation to better suit our farmers' needs. Students from the University of Puerto Rico could use these opportunities to improve their academic curriculums while helping our farmers and therefore our food security. **Target audience** Dairy farmers would benefit from this initiative by increasing their accessibility to some of the current technologies used to improve production efficiency. Students from the Departments of Engineering, Business Administration, Biology and Agricultural Sciences. **What has been done?** Interdisciplinary and interuniversity groups (30 students) were trained in basic management of tropical dairy farms, challenges of the dairy industry, business model canvas, marketing, intellectual property and communication skills. The groups developed functional prototypes to solve pre-identified challenges (identified by Extension dairy stakeholders and Extension specialists). The PRAEXS Experimental Dairy Farm	2. Animal systems

		served as the student lab to develop and validate their prototypes. Students used what they learned to develop their prototypes and present them to a board of judges at the Agro-Innovation Hackathon day. **Results** Five prototypes were created by the participating students. The targeted dairy farm challenges were related to sustainable pest management, milk quality monitoring and cow comfort. From these 5 prototypes, two were recommended to submit a UPRM Patent Disclosure Form, from which only one has been submitted. The results of this project were presented in three dairy stakeholder meetings. More than 20 farmers reported being interested in helping students to further develop their prototypes and in providing ideas for future projects like this. **Other information such as relevant websites is optional.** https://www.uprm.edu/portada/2019/08/16/ganan-reto-agroemprarial/	

9.	Puerto Rico Beef Cattle Quality Assurance Program Certification and Extension Beef Cattle Initiative	**What is the issue?** During the past decades, the local beef industry has been battling discriminatory and disadvantageous treatment with respect to beef importers. The local production of beef now accounts for only 10% of what we consume, seemingly affected by the adverse publicity and poor management practices followed by beef ranchers. Puerto Rico's beef cattlemen need new production and marketing strategies that can add value to the beef they produce, thus, improve cattle prices and farm income. Year-round grazing allows cattlemen to easily target the grass-fed beef niche market. It is imperative to offer local beef producers tools to improve their competitiveness and promote the development and expansion of the livestock industry and the production and subsequent process of locally produced fresh grass-fed beef. We are encouraging that any beef produced, locally or imported, is brought to the local market under the strictest measures of quality and safety for the benefit of our consumers as a means to increase local beef consumption. **Target audience** Beef Cattle Producers, mostly grass-fed, and all those involved in the local meat market chain. This includes meat processing managers, meat sellers, slaughterhouses and meat processors. Additionally, members of the local Cattlemen Association, Beef Cattle Production Fund, Beef Producers Cooperatives and Extension County Agents working with beef cattle producers.	2. Animal systems

		What has been done? Technical workshops and training were offered throughout the island in collaboration with local, large animal veterinarians and county agents. Topics were aimed at improving production and quality of the final product and cattle wellbeing, recommended management practices, production through slaughter, meat quality, meat processing and safe handling. Follow-up visits by Extension County Agents were carried out to report progress and changes. To better address the benefits of grass-fed systems on the quality of beef cattle and meat, studies on management and feeding strategies to enhance grass-fed beef cattle production were conducted, as well as carcass characteristics and meat quality evaluations. Additionally, during this reporting period, 50 beef cattle producers were trained in practices promoting animal protection and welfare. **Results** A total of 180 participants completed the Beef Quality Assurance Certification and reported to have adopted one or more recommended practice as Grass-fed Beef Producers. Personnel in charge of local meat markets were trained and certified in the most economically important meat cuts, local beef cuts as well as in the safe handling of meat (45 participants).	

		Field research trials have preliminary shown that the use of creep-feeding type supplementation enhanced the growth of pre-weaning calves, and that growth of intact males was higher than castrated ones. Some of the reported results of the PRAES Beef Cattle educational program included: · 8 farmers adopted at least one biosecurity practice on their farm · 30 beef cattle producers adopted practices that promote animal protection and welfare on their farms. · 9 ranchers increased animal production after adopting recommended practices of record-keeping, disease control, prevention and feed utilization. · 35 farmers adopted parasite control practices on their farms · 4 adopted sustainable farming practices · 4 framers improved animal reproduction · 5 improved nutrient utilization practices · 15 adopted practices for heat stress control · 10 increased the size of their farm · 13 adopted one or more recommended technique in implementing the planting of alternative crops / forages to improve the use of nutrients in livestock production **Other information:** An online training course on PR Beef Quality Assurance Quality Certification is being developed. This will be for further training of the interested audience.	

10.	Restoring citrus production in Puerto Rico with quality citrus plants and managem ent practices	**What is the issue?** Huanglongbing (HLB) or citrus greening is widespread in Puerto Rico and is a threat to citrus production. Citrus growers on the island have relied on the production and maintenance of disease-free citrus varieties by the PRAEXS. However, commercial nurseries need support in testing for systemic pathogens. The Citrus Clean Plant Network, through the PR Plant Diagnostic Clinic in the Juana Diaz substation, collaborates with citrus growers and the PR Department of Agriculture in the production and maintenance of HLB-free citrus propagative materials grown in screen-protected structures. PRAES engage with growers and the general audience to disseminate information about good agricultural practices ameliorating the negative effect of HLB. **Target audience** Citrus growers in Puerto Rico who will have available "quality declared" citrus plants. Access to testing for commercial nurseries will guarantee the production of HLB-free citrus plants, which will impact both citrus producers and the public. Extension Service educators will receive information about the best management practices for citrus orchards and will make recommendations to citrus growers. **What has been done?** Citrus germplasm at the Experiment Stations in Isabela and Adjuntas, part of the citrus collection maintained under greenhouse conditions, tested free of HLB and Citrus Tristeza Virus (CTV). Commercial nurseries in Las Marias and Sabana	*3. Integrated Management of New and Emerging Pests and Diseases*

		Grande have 300,000 citrus plants for retail sale. The Citrus Clean Plant Network is conducting the testing for HLB and CTV. Field trials and experiments with citrus varieties, planting methods, and best management practices continue at PRAEXS substations. **Results** The citrus collection at the Experiment Stations is comprised of 55 plants and 27 varieties. All tested negative for HLB and CTV. These citrus varieties were renewals from the Corozal collection, grown under a protected structure. Commercial nurseries "El Eucalipto" in Las Marias and "Finca La Plata" in Sabana Grande had 100,000 and 70,000 "Valencia" plants, respectively, grafted on "Swingle", "Carrizo" and "Brazilian Sour". Two percent of 20,000 plants were tested for HLB and CTV. These nurseries are producing citrus plants under screen-protected structures. A field trial conducted at the Isabela substation, evaluated the performance of 'Marr's Early' and 'Pera' sweet orange (*Citrus sinensis*) scions grafted on 'Carrizo', 'HRS 802', and 'HRS 812' rootstocks. Results indicated that tree height, diameter, fruit production and juice content were higher in both sweet oranges grafted on 'HRS 802' compared with those on 'HRS 812' and 'Carrizo'. Fruit quality was determined from juice content (%), total soluble solids [°Brix], and pH. Leaf tissue analyses showed an optimum range for Ca, Mg, Na, P, B, Cu, and Zn, an indicator	

		of tree health. 'HRS 802' rootstock can be recommended to local farmers growing sweet oranges in Alonso series soil. The Experiment Station of Adjuntas sold 8,800 tested citrus plants to a total of 54 citrus growers. A field experiment in Las Marias evaluating the use of supplemental nutrition in citrus was conducted. The use of a drone to assess disease incidence was included as part of the demonstration project. A publication about nutritional management was distributed to farmers and agronomists. Based on these results and using the field experiment, more than 100 citrus growers, extension educators and public received orientation in management and supplemental nutrition at a field day demonstration. Twenty-nine citrus growers adopted the use of good management practices to ameliorate HLB's damage. **External Factors (optional)** The limited number of suppliers of greenhouse materials on the island has delayed the completion of repairs to the screen-house for tested citrus plants for sale at the Isabela substation. **Other information:** **Publications:** Mathanker, S., C. Estévez de Jensen, L. Pérez-Alegría, A. Pagán. 2019. UAV color images for determination of citrus plant parameters. J. Agric. Univ. P.R. 103 (2): 141-154.	

		Tirado-Corbalá, R., A. Segarra-Carmona, M. Matos-Rodríguez, D. Rivera-Ocasio, C. Estévez de Jensen and J. Pagán. 2020. Assessment of two sweet oranges grafted on selected rootstocks in an Inceptisol in Puerto Rico. Horticulturae 2020, 6(2), 30; https://doi.org/10.3390/horticulturae6020030. Viteri, D.M., C. Estévez de Jensen and E. Ordóñez. 2019. Reaction to Huanglongbing of 'RICO' Citrus germplasm grafted in two rootstocks. Proceedings Annual Meeting of the Puerto Rican Society of Agricultural Sciences. San Juan, Puerto Rico. p. 8.	

11.	Puerto Rico's Plant Diagnostic Clinics (PRPDC) are achieving accurate diagnosis of pathogens and insects and developing IPM strategies for pest and disease managem ent.	**What is the issue?** Growers, seed companies and the public need a reliable resource for disease and insect identification in Puerto Rico. Management practices to control disease and pests also need to be created and disseminated to the stakeholders. In addition, the registration of pesticides is essential for new and emerging diseases and pests. **Target audience** Seed companies in Puerto Rico that receive service at the PRPDC to comply with the Phytosanitary Regulations of different countries. Growers and homeowners that submit samples to the different Diagnostic Clinics for disease or pest identification. Growers that receive recommendations for managing diseases and pests of their agricultural crops. Agricultural agents that obtained trainings on disease and pest identification and demonstrations of management options. **What has been done?** The Puerto Rico Plant Diagnostic Clinic (PRPDC) in Juana Diaz received accreditation from the National Plant Diagnostic Network. The PRPDC's five-year accreditation term began May 1, 2020. The PRPDC updated the Quality Manual and Procedures, work instructions and forms. Plant diseases and pests of a variety of agricultural crops and ornamental plants were identified. Growers received recommendations for disease and pest management. Diagnosticians visited problem	*3. Integrated Management of New and Emerging Pests and Diseases*

		areas to provide training and educational materials generated by the clinics. **Results** From the 650 samples processed by the PRPDC last year, fungi accounted for 42% of the pathogens identified in the samples. A new disease in ornamental asparagus was described. Viruses were identified on 32% of the samples with *Begomoviruses* and *Tospoviruses being* the most prevalent. In cilantro, a new viral disease was identified. Bacterial diseases were detected on 23% of the samples, and the most common were blights caused by *Erwinia chrysanthemi*. The Extension Disease Clinic in Mayagüez, analyzed a total of 384 samples and the clinic in Rio Piedras processed approximately 112 plant samples and 18 soil samples for nematode analysis. The plant samples were of fruits, vegetables, coffee, ornamentals, banana and plantain. Pesticide efficacy trials were conducted on the following crops: papaya, avocado, sugarapple, pineapple and cassava. Efficacy, phytotoxicity and crop safety data was obtained. **Other information:** A working group on "Fusarium Wilt RT4 in Bananas", has been created in response to the threat of the disease to PR banana and plantain production. A pocketsize and standard size identification field guide to poinsettia pests and diseases was prepared. Fact sheets being	

		revised will be published, printed and distributed during summer/fall 2020. https://sites.google.com/upr.edu/pascuaspr In the NPDN Fifth National Meeting in Indianapolis, Indiana, information about a new disease in tomatoes and pineapples in PR was presented. New fact sheets about pesticides registered in banana and coffee production have been developed, distributed to farmers and released on the IR-4 PR webpage. http://ir4.eea.uprm.edu/	

12.	Banana Rust Thrips early monitoring and IPM practices help improve local banana production	**What is the issue?** In Puerto Rico, plantain and banana are the most important crops of the farinaceous sector. Plantain and banana produced locally are destined for the local fresh market. Because of their relevance for local agriculture and consumer preference, local farmers are conscious about the need to maintain good quality fruit for local markets. Production of plantain and banana is affected by damages from several pests. The most important are nematodes, black weevil and fungi causing sigatoka. Recently, banana farmers have faced a new threat, the banana rust thrip, *Chaetanaphothrips signipennis* (Bagnall). Damage caused by this insect on farms in PR is a major concern. Feeding during adult and nymphal stages causes the damage. The early symptoms appear as water-soaked smoky areas where the colonies congregate to feed and oviposit between touching or adjacent fruit. These areas then develop the typical rusty-red to dark brown-black discoloration. **Target audience** County agents and banana farmers **What has been done?** Demonstration plots promoted the adoption of cultural practices and early monitoring for thrip detection. Premature bunch bagging was evaluated using sulfur, spices and bifenthrin bags, and conventional bunch bagging with bifenthrin 0.1% and a control. Rust thrip damage was less than 10% in both treatments. In weekly visits, the banana	3. Integrated Management of New and Emerging Pests and Diseases

		specialist and the IPM specialist in collaboration with PRAES county agents monitored the presence of the thrip in participating banana farms. **Results** During 2019, thrip monitoring on affected farms and promoting IPM to banana and plantain farmers were carried out. Damage caused by rust thrips in Puerto Rico banana production was reduced by the implementation of IPM techniques by farmers. As a result, banana production for the local market was improved. Also, the knowledge of banana producers and Extension agents in scouting the "rust thrip", using guides for recognition and management, increased. As a result of the recommendations and publications given in farm visits and during the survey, all banana farmers adopted at least 4 IPM practices to manage the thrip. **Other information:** Two leaflets were prepared and distributed through PRAES Extension agents. One describing the thrip biology, identification and management (Alvarado-Ortiz, A. N., 2018. "Trípido de la Mancha Roja del Guineo y Plátano". USDA-NIFA and PRAES). A second leaflet presented different options for premature bagging (Diaz-Rivera, M. 2018. "El embolse de los racimos". USDA-NIFA and PRAES).	

		A poster presented at the annual meeting of the Puerto Rican Society of Agricultural Sciences (SOPCA) received recognition in the category of educational posters (Diaz-Rivera, M., C. Soto Ramos, W. Almodovar, A. Alvarado and I. Irizarry. 2018. "Manejo Integrado del Tripido de la mancha roja del Guineo". USDA-NIFA and PRAES).	

13.	Contributions to the long-term sustainability of forest ecosystems through novel forest silviculture, biomass waste reuse, and the valuing of ecosystem services	**What is the issue?** In Puerto Rico, the growth of forests dominated by introduced species, termed "novel", is the result of agricultural abandonment, which has impaired the island's capacity to provide food for its population. Novel forests represent a vast, renewable and untapped natural resource that can provide ecosystem services, including scenic beauty and opportunities for recreation as well as for producing goods. Yet, so far, these forests produce little for landowners or residents. It is important to devise ways to use "novel" forests to support food production and the conservation of native tree species. Moreover, the value that residents of urban areas assign to ecosystem services and recreational opportunities from urban forests must be taken into account. As for production of goods, the hurricanes that frequently impact the island usually leave a surplus of vegetative material with many potential uses. Most of the material collected is considered biomass waste that can be converted into biochar and wood chips. Finding alternative uses for this material in a sustainable and economically sound way is also a priority. **Target audience** Agricultural Extension agents, scientists and stakeholders interested in forestry, particularly those interested in starting a business in forest products. Farmers and landowners interested in applying agroforestry practices in their lands and production systems Undergraduate and graduate students	4. Climate Change, Natural Resources and Environment

		Employees of private organizations and of government agencies interested in tropical agroforestry systems and their benefits to soil health. Community leaders and residents of areas contiguous to urban forests **What has been done** The establishment of a long-term experiment for testing the success and response to management of agroforestry enrichment plantings across 30 novel forest study sites. Data and research material include records on growth and survival of six fruit/crop tree species (avocado, breadfruit, cacao, coffee, jácana and jagua) planted across 30 novel forest sites dominated by introduced N-fixing and non N-fixing species. This includes data on growth and survival of enrichment plantings on ten sites planted before the passing of Hurricane María on September 20, 2017, and 20 sites planted within six months after the hurricane. Production of biochar began at the Mayagüez campus farm and at the Corozal substation using material from invasive species present at the substation. Tests of different materials for biochar production were made. Each biochar was later tested in a greenhouse, growing basil. A sawmill was also purchased and assembled at the UPRM Alzamora farm for research into wood properties and uses. Outreach included the production of research content material adapted to the Spanish-speaking audience and workshops on forest product management and uses. A workshop on forestry and forest products was held on May 1, 2019 for the general	

		public. The forum was divided in two parts, presentations and later a round-table discussion about the needs of forestry in Puerto Rico. A second workshop about growing mediums for tree growth that included a demonstration on making biochar with kon-tiki kilns was held on August 7, 2019 at the Corozal experimental station. Also, a workshop in collaboration with the Caribbean Climate Hub on the safety use of chainsaws was held in August 2019. This workshop was open to the general public and we were able to train technical personnel as well from the university and from the Corozal Substation. -A combination of literature reviews and interviews were used to identify the most important ecosystem services obtained from urban forests. A contingent valuation method was used to estimate the value of urban forests and their ecosystem services. Experimental methods were used to estimate the value of recreational opportunity-associated characteristics of the San Patricio Urban Forest in the metropolitan area of Guaynabo, PR. **Results** Significant results include: (1) descriptive data on the variation in tree structure and species composition found across 30 novel forest sites before and after Hurricane María, (2) evidence showing that leaf area index (LAI) and leafing phenology (time and duration) is affected by the dominant introduced species and functional group (e.g., N-fixer vs. non N-fixer) in novel forests, (3) data on survival of fruit trees planted before and after Hurricane María across 30 study sites,	

		(4) preliminary observations that suggest no effects of dominant species on growth and survival of cacao, coffee and jácana, but higher growth and greater survival of avocado, breadfruit and jagua planted in novel forest sites dominated by highly deciduous species and N-fixers. Additional results indicated that novel secondary forests provide adequate protection from a category 4 hurricane to enrichment plantings established underneath the canopy, and that shade adapted fruit tree plantings of cacao flowered two years after planting, illustrating they can be established successfully across novel forests. Forestry enthusiasts, scientists and farmers attended the workshops on forest products and growth mediums. Over 30 people were educated in the safe handling and use of chainsaws. Results from the urban forest valuation study indicate that residents place a high value to ecosystem services provided by urban forests in Puerto Rico. Moreover, findings suggest that environmental engagement and perceptions affect the perceived value of ecosystem services. Residents also indicate that they are willing to pay for recreational enhancements in the San Patricio Urban Forest of Puerto Rico. The results suggest that the two most preferred recreation enhancement projects are improved trails and a community garden. The results also imply that projects aimed at increasing urban forest-based recreation opportunities maybe justified depending on respective project costs.	

		Results from forestry research have been disseminated in conjunction with PRAES through multiple publications, workshops, courses, scientific meetings and presentations to diverse audiences. **Other information** Abelleira Martínez, O.J. (In Press). Taller ADAPTA #3: Agrosilvicultura en bosques noveles para mejorar la resiliencia social-ecológica al cambio climático en Puerto Rico. In: ADAPTA Workshop Informative Sheet Series. USDA Forest Service Caribbean Climate Hub, International Institute of Tropical Forestry, Río Piedras, Puerto Rico. Abelleira Martínez, O.J. 2017. El huracán María en Añasco y sus efectos en sistemas sociales-ecológicos del norte y oeste de Puerto Rico. Acta Científica 31: 60-78. Abelleira Martínez, O.J. 2019. Geographic distribution and spatial attributes of African tulip tree forests in north-central Puerto Rico: Implications for social-ecological resilience. The Journal of Agriculture of the University of Puerto Rico 103: No. 1. Abelleira Martínez, O.J. 2019. Servicios ecológicos y estrategias de reforestación en Costa Rica y Puerto Rico: Lecciones para mejorar la resiliencia social-ecológica. Presentación oral en el Seminario de los 50 años de la Oficina de Programas Internacionales del CCA. 20 de marzo de 2019, AP-01 del Edificio Piñero, RUM.	

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		socio-ecológicos: Manejo de áreas boscosas en fincas agrícolas como estrategia de adaptación al cambio climático. April 21, 2018, Mayagüez, Puerto Rico. Scharenbroch, B. 2019. Biochar and its impact on tree growth and health. "Actividad Educativa sobre Medios de Cultivo para Árboles, Corozal, PR." at Corozal Agricultural Experiment Substation,UPR, August 7, 2019. Tavárez, H., & Elbakidze, L., 2019. Valuing recreational enhancements in the San Patricio Urban Forest in Puerto Rico: A choice experiment approach. Forest Policy and Economics 109, 102004. Tavárez, H. (April, 2019). Willingness to pay for ecosystem services in Puerto Rico: Results from a contingent valuation method. Poster presented at the 2nd Congress of Applied Economics held in Mayaguez, Puerto Rico.	

14.	Soil Quality and Nutrient Management in Tropical Soils	**What is the issue?** Soil management is an important aspect for climate change mitigation as well as for adaptation. There has been an increasing need for soils instruction and education for the PRAES county agents. With the county agents servicing hundreds of farmers throughout the year and providing informal education to members of the communities across the island, they require adequate training by specialists to improve the information and education they provide to their target audience. PRAEXS is supporting this process through a project that is working towards creating a soil data bank that will facilitate soil management and use, preserving the quality and health of soils. **Target audience** The target audience includes PRAES county agents, USDA agency personnel, farmers, producers, government professionals, community leaders and members, and 4-H youth. **What has been done** PRAES county agents received training by the recently hired PRAES soil specialist in topics related to soil sampling, soil analysis interpretation, nutrient recommendation, soil nutrient management, and soil quality/health. Classroom workshops covering soil sampling, soil analysis interpretation, and	4. Climate Change, Natural Resources and Environment

		nutrient recommendations were provided to PRAES county agents for three of the five PRAES regions. A second workshop titled "Integrando el conocimiento del recurso suelo: del campo al laboratorio" was held in which county agents characterized soils in the field and participated in analyzing soil samples in a laboratory. Two PRAES regions have already participated in the second workshop with dates scheduled for the remaining three areas to receive it. Workshops on soil nutrient management have been provided to USDA NRCS personnel Collaborations between the PRAES and NRCS have resulted in the dissemination of soil nutrient management information to the general public. Experimental plots for cultivated and non-cultivated Oxisols (Cotito series), and Mollisols (Yauco series) were established at the Isabela and Juana Diaz Agricultural Experiment Substations. Soil chemical and physical properties of selected Oxisols and Mollisols have been evaluated. Two sampling depths, 0-8 cm and 8-13 cm, were selected and the bulk density of the soil, stability of aggregates and resistance to penetration were evaluated. Data on selected soil quality parameters was collected for Mollisols and Ultisols. Two soil quality models are under evaluation to determine a minimum soil data set to rank soils in terms of quality and health.	

		Results 40 of the 60 PRAES county agents have been re-trained in soil sampling, soil analysis interpretation, and nutrient recommendations 24 PRAES county agents participated in the characterization of soils and laboratory analysis workshops. 50 USDA-NRCS personnel received training in soil nutrient management. Soil samples were collected on 2 soil series and chemical and physical parameters were evaluated. Results obtained for the Mollisol (Yauco series) showed the uncultivated soil had lower bulk density values than those of cultivated soil, with average values of 0.86 g cm^3 and 0.91 g cm^3, respectively. The high organic matter content of Molisols favors low bulk density values compared to other mineral soils. The percentage of aggregate stability was greater at the depth of 8-13 cm than in the first 8 cm of the soil surface. For the Oxisol (Cotito series) a significantly difference in soil bulk density was observed between the uncultivated and the cultivated soil. In the uncultivated soil it was 1.06 g cm^3 and in the cultivated one it was 0.98 g cm^3. Aggregate stability was higher in uncultivated soil, at the depth of 0 - 8 cm, which can be attributed to a higher content of organic matter on the surface and to the stabilizing presence of oxides in these highly weathered soils. These, among other parameters evaluated, are attributes that	

		are sensitive to management practices and serve as tools for the conservation and resilience of the soil resource. Knowing the quality condition of a soil allows us to establish a better management of the resource to avoid the loss of its fertility and good quality. **Other information such as relevant websites is optional.** https://www.uprm.edu/sea/mdocs-posts/sea-del-oeste-vol-3-2019/	

15.	Value added products from farinaceous crops: the quest for new market alternatives and increased food security in Puerto Rico	**What is the issue** Puerto Rico's farinaceous crops have great quality and potential for establishing a value-added industry. Adding value to the island's principal crops can minimize post-harvest losses, encourage exports to profitable niches, and guarantee a more continuous supply of goods in the case of extreme meteorological events such as the ones now being frequently experienced in the region. Yet, to achieve this goal studies are needed on the processing characteristics of the selected crops and new products need to be formulated with qualities that satisfy consumer's tastes and preferences. **Target Audience** Plantain and other farinaceous crops growers, Scientists in the public and private sector working with technology for processing vegetables **What has been done** Evaluation of the processing characteristics of Maiden plantains compared to those of Maricongo variety. The Maiden plantain hybrid was introduced to Puerto Rico by the PRAEXS and shows improved yields over the commercial favorite Maricongo. Tests were performed on mature green and ripe fruits under typical Puerto Rican cooking processing techniques such as peeling, cutting, mashing, boiling, frying, freezing and baking. Flour processing from *apio (Arracacia xanthorrhiza)* and plantain (*Musa paradisiaca)* were chosen as a suitable post-	5. Food Safety, Science and Technology

		harvest preservation strategy for these crops. Physicochemical and functional properties of apio flours prepared from the storage root, the rootstock and stems were investigated. Tubers were peeled, sliced, dried at 40 °C for 24 hrs, milled, sieved through a 60 mesh, and packaged. **Results** Both cultivars, Maiden and Maricongo, were classified into four categories: green (Stage 1 or 2), green-ripe (Stage 3 or 4), ripe (Stage 5 or 6), over-ripe (Stage 7). Categories were used to conduct the research and for the discussion of results. For both varieties in stages 1 to 7: there were no significant differences in color of peel, chromaticity of peel and pulp, maturity scale and enzymatic activity. In stage 3 or 4 there were significant differences in pulp color and luminosity, pH, degree brix and humidity. In stage 7, there were significant differences in peel color. When evaluating mechanical properties for stage 1 to 6; there were no significant differences in cutting resistance, peeling force, stowage test and impact resistance. For processing characteristics, there were significant differences between both varieties for fat absorption. This difference was found on stages 1 to 6. Significant differences were found for pulp yield and water absorption on stage 1 or 2. This information can be useful to further asses the commercialization path that should be followed with the Maiden variety.	

		Significant differences in physicochemical and functional properties were observed ($P < 0.05$) among apio flours. Chemical composition of flours ranged from 5.48 to 6.37% moisture, 2.12 to 6.69% protein, 0.8 to 1.28% total fat, 5.25 to 8.05% ash, 3.49 to 4.12% crude fiber, 74.38 to 81.97% total carbohydrates and starch content of 83 to 85%. Total phenolic content (Folin-Ciocalteu method), antioxidant activity (DPPH method) and β-carotene content (UV-Vis Spectroscopy) varied from 45.42 to 82.22 mg GAE/100g, 39.10 to 132.50 µM Trolox/g and 0.35 to 0.75 mg/100 g respectively. Acidity (titration method), pH and Aw ranged from 0.47 to 0.64%, 6.21 to 6.35 and 0.17 to 0.27, respectively. All flours showed the maximum value in the water absorption index (6 g gel/g sample), and water solubility index increased from 40 to 60 % in the range of 60 to 100 °C. Apio flour prepared from rootstock had the highest bulk density (0.39 g/mL) and oil absorption capacity (2.39 g/g). The chemical and functional properties of the stem are very similar to those in the storage root making it a potential alternative for processing. **Other information:** RN.Chávez-Jáuregui, K. Lara Leiguarda, F. Negrón Aviles, C. Pérez Menendez, H. Pérez Acevedo. Puerto Rican apio (Arracacia Xanthorrhiza Bancroft) flour: physicochemical and functional properties. 2019. Simpósio Latino Americano de Ciẽncias de Alimentos (13 SLACA). November 10 - 12, Campinas, São Paulo, Brazil.	

16.	Food Manager's Food Safety Course	**What is the issue?** The Puerto Rico Health Department adopted the Food Code in 2000. As part of the regulation's requirements, all persons in charge of a food establishment must approve a certified food safety course. **Target audience** People in charge of retail food establishments must comply with the Food Code regulation. Without the Manager's Food Safety Certification, they will not be able to obtain or renew their permits. Without a permit they will not be able to operate their food establishment. This audience consists of managers or owners of a great variety of food establishments such as restaurants, food trucks, hot dog stands, cafeteria, School Lunch Program, and other establishments that serve the People-at-Risk population. **What has been done?** PRAES has offered 58 Food Safety Manager's Courses and corresponding exams from the National Registry for Food Safety Professionals (NRFSP) to Food Managers/Owners. The Food Safety Course includes all the topics required by the Food Code such as employee's health, cleaning and sanitizing, cooking temperatures, among others. **Results** A total of 1,176 Food Managers completed the course and 1,152 passed the food safety test certification. The 21 participants that did not originally passed the certification,	5. Food Safety, Science and Technology

		received a refresher course and took the certified test for a second time and passed. These managers are now in compliance with the Food Code of 2017 and were able to obtain or renew the permits to operate their food establishments. From the total of participants, 873 managers reported to adopt at least 3 safe handling practices. Among these practices included: implementation of minimum cooking temperatures, appropriate hand washing, employees' health and hygiene, Standard Operational Procedure (SOP) for the appropriate management of human fluids such as vomit and feces, avoidance of food cross contamination, proper general cleaning and sanitizing for food establishments, among others.	

17.	Families Be Food Safe	**What is the issue?** Literature establishes that consumers do not perceive their home as a place in which they could get a foodborne illness. Safe handling practices are necessary to reduce the probability that a foodborne illness occurs. Therefore, food safety education should target behavioral changes that reduces the risk. **Target audience** General public/At-Risk Population **What has been done?** PRAES Family and Consumer Science Educators (FCSE) offered short food safety courses to the general public. These courses emphasize the four core elements of food safety: clean, separate, cook, and chill. FCSE customize the course according to the audience's needs. There are lessons that include food safety information for moms to be, the elderly; food safety when there are power outages, during holidays, and food safety during canning. These lessons are offered as part of food preparation courses or demonstrations, or as food safety courses. **Results** 912 consumers completed the Families Be Food Safe Course. Of these participants 840 adopted at least one safe food handling practice. Among the practices that were adopted are: hand washing, separating to avoid cross contamination, cooking at recommended temperatures, and cooling. Within	5. Food Safety, Science and Technology

		these participants, 21 Moms-to-Be completed our Moms-to-Be Food Safety training and 20 of them adopted safe handling of baby bottles, baby food, formulas, and breastmilk.	

18.	The market potential for differentiated coffee and milk products in Puerto Rico: consumers' preferences and willingness to pay.	**What is the issue?** Farmers in Puerto Rico face each year complex challenges that reduce the profitability of their businesses and threaten the sustainability of their operations and the already limited food security of PR. Better knowledge of consumers and local markets may help growers identify profitable market niches that could support their commodities future outlook, and help policymakers create more efficient agricultural policies. Product differentiation is a strategy used to showcase a certain product's characteristics that make it different from similar products in the market. Yet, in Puerto Rico, very little is known about consumer preferences and willingness to pay for differentiated products. To begin addressing this gap a study to estimate consumer willingness to pay for differentiated coffee and milk products was conducted, and results were disseminated to diverse audiences. **Target audience** Coffee and milk producers and consumers interested in differentiated products Agricultural agents who received training and were oriented about the significance of differentiated products and their potential markets, so they could give continuation to project results. **What has been done?** Consumer willingness to pay for differentiated milk and coffee products was estimated by using the choice experiment	6.Community Resources for Sustainable Development, Agricultural Economics, Marketing and Added Value

		method. Attributes explored in the survey designed for coffee included product origin, type of product, production type, fair trade pay, and cost per bag. In the case of milk, attributes included in the survey included product origin, chemicals (conventional, hormone free), type of product, animal feed, animal management and cost per liter. Results were disseminated through peer-reviewed journals, oral and poster presentations, an educational video on the methods used, and presented to students, agricultural agents, stakeholders, government officials, and farmers and ranchers in annual meetings organized by personnel of the Agricultural Experiment Station and of the Agricultural Extension Service. **Results** Researchers found that consumers are willing to pay between $2.44 and $6.38, in addition to the current price, for an 8-ounce package of coffee with different production characteristics. It was also found that consumers are willing to pay between $0.74 and $1.26, in addition to the current price, for half gallon of cow's milk with different production characteristics. These results indicate that there is a market potential for differentiated coffee and milk products in Puerto Rico and can help to evaluate the viability of adopting new production and marketing strategies for these products. **Other information:** Tavárez, H., Álamo, C, & Cortés, M. (Jul. 2019). Differentiated coffees and their potential markets in Puerto Rico: An	

		economic valuation approach. Proceedings of the Caribbean Food Crops Society Annual Meeting, Punta Cana, Dominican Republic. Tavárez, H., Alamo, C., & Cortés, M., (Nov. 2018). Niche markets for differentiated milk in Puerto Rico: A choice experiment approach. Abstracts of presentations at the Puerto Rican Society of Agricultural Sciences Annual Meeting, Aguadilla, Puerto Rico. **Podcasts** https://www.uprm.edu/desdelaeea/2019/10/07/cafes-diferenciados-y-sus-mercados-potenciales-en-puerto-rico/ https://www.uprm.edu/desdelaeea/2019/09/16/segmentos-de-mercados-por-leche-de-vaca-diferenciada-en-puerto-rico/	

19.	Training and workshops help communities to achieve higher levels of resilience	What is the issue? After hurricanes María and Irma, communities continue to be aware of the importance of becoming self-sufficient. They realize that the local government does not have the capacity to meet deal simultaneous emergencies across Puerto Rico. Communities are now more receptive towards learning how to be prepared and respond faster to emergencies, and towards becoming more resilient. One of the strategies that PRAES promote as a means to better cope with emergencies is through the start-up of new microenterprises. Communities are more inclined to attend to PRAES training and workshops to learn more about economic opportunities thru self-employment, community organization, and emergency-plan development. **Target audience (13)** Voluntary leaders and community members that would be benefited from PRAES trainings and workshops. **What has been done?** A combined total of 855 voluntary leaders and community members were trained following the curriculum for strengthening community leadership. Leaders interested in FCC, Agriculture, Community Development and 4-H programs, participated in the trainings and workshops. The courses (36) empowered participants and helped them to identify their strengths, weaknesses, opportunities, and threats. **Results**	6. Community Resources for Sustainable Development, Agricultural Economics, Marketing and Added Value

		As a result 4,670 hours of community voluntary labor were offered by trained voluntaries, which in terms of money equivalency, it represents a contribution of $31,270 to participating communities. Sixteen voluntary leaders founded microenterprises dedicated to manufacturing of clothes, homemade pastries, handmade cosmetic products, herbal soaps and catering services *for* events. These microenterprises have helped the communities to bring~~ing~~ additional incomes to their families and to become more economically independent.	

20.	Promoting Family and communit y financial strength	**Target audience** Voluntary leaders (16) *participating in a course about* promoting family and community financial strength. The course was sponsored by a local Industrial Cooperative. The purpose was to raise awareness about the importance of community collaboration as a means to promoting family and community financial strength. **What has been done?** The Cooperative organization *started* the partnership by allowing the PRAES participants the use of their premises and their sewing machines, thus permitting the beginning seamstresses to become trained in the needle industry. Thanks to this collaboration, however, course participants became more interested in the saving and *cooperative* philosophy of their partner, helping them to achieve better *financial results*. **Results** After participating in the project, three of the participants ~~have~~ bought shares in the Industrial Cooperative and have been serving as volunteers in the cooperative's tasks for more than a year. Of these participants, *two* hold leadership positions on the cooperative's board of directors. Currently, a total of twelve PRAES participants *dedicate* more than thirty five hours a week to improving the finances of the industrial Cooperative and do so on a voluntary basis. **Other information such as relevant websites is optional.** https://www.facebook.com/cicomerio/	6. Community Resources for Sustainable Development, Agricultural Economics, Marketing and Added Value

21.	Healthy eating and physical activity: Encouraging positive behavioral changes towards the prevention of adult and childhood obesity	**What is the issue?** Obesity has been associated with major causes of mortality in the US and PR: cancer, cardiovascular diseases and diabetes. According to the statistics from the Center for Disease Control 33% of Puerto Rican adults (18 years and over) were obese and 24% of Puerto Rican adolescents (grades 9th through 12th) were overweight or obese. Children that are obese have a higher risk of developing degenerative diseases like cardiovascular disease and diabetes in their adulthood. It is important that children develop healthy eating practices such as consumption of fruits, vegetables and whole grain cereals which have been associated with the prevention of obesity **Target audience** Children and youth that are members of Extension 4-H Clubs and adults in general. **What has been done?** PRAES interventions focus on healthy eating and increase physical activity to promote positive behavior changes towards the prevention of adult and childhood obesity. In order to promote behavioral changes that lead to healthy eating practices, Extension Family and Consumer Sciences' educators offered nutrition interventions to the participants. Intervention consisted of short nutrition courses. The short course entitled *Moving to Healthy Eating* targets the youth participants and consisted of six lessons that were taught face-to-face on a period of 45 to 60 minutes on the following topics: the importance of healthy eating, barriers to healthy eating, the use of MyPlate, and strategies to increase	8. Adult and Childhood Obesity

		consumption of fruits and vegetables, whole grain cereals, healthy snacks and physical activity, followed by experiential learning activities on these topics. This course encourages the consumption of fruits, vegetables and whole grain cereals in order to develop healthy lifestyles that prevent childhood obesity. Two other short courses entitled *I Eat Healthy* and *Taking Control for Healthy Eating* targeted the adult population. **Results** A total of 1,260 youth participated in the nutrition short course *Moving to Healthy Eating. From the participants,* 26% reported to increase consumption of fruits after, 21% reported increased consumption of vegetables, 23% reported increased consumption of whole grains and 46% increased their physical activity levels. From the 992 adults that participated in the nutrition short courses, 54% reported increased consumption of fruits, 48% reported increased consumption of vegetables and 30% reported increased consumption of whole grains and 42% increased their physical activity levels.	

22.	Promoting Healthy Lifestyles	**What is the issue?** According to multiple publications, adults living in Puerto Rico have several lifestyle risk factors and high prevalence of chronic diseases. Conditions such as diabetes, asthma, hypertension, cancer (including breast cancer), cardiovascular diseases and depression predominate in this group. Unhealthy lifestyles such as physical inactivity, poor diet, alcohol consumption and smoking are associated with the chronic disease burden. The literature highlights the importance of adopting healthy lifestyles as well as periodic monitoring and screening for prevention, early detection and treatment of chronic illnesses. The Family and Well-Being program worked to ensure that families gained the skills needed to manage the issues that impact their lives, in order to empower them to make healthier lifestyle decisions. **Target audience** Families, people in charge of groceries, single women, children, heads of families, communities and low-income adults. **What has been done?** The Extension Family and Community Educator group provided workshops and courses focused on promoting healthy habits to low income adults, women and older adults. The Family and Well-Being component established an educational intervention initiative to educate and promote breast cancer screening among women living in socio-economic deprived communities.	9. Family Well-being

		Through the Family and Well-Being Program, Extension Educators conducted and delivered courses on health promotion, healthy lifestyles and diseases prevention to increase knowledge and encourage participants to adopt healthy lifestyles. Also, in a partnership with Puerto Rico Comprehensive Cancer Center (PRCCC), a train the trainer workshop was provided to Extension Educators about breast cancer prevention Once capacitated, Extension Educators trained the clientele about topics related to breast cancer such as its risk factors, diagnosis, treatment, early screening and healthy habits to help women from vulnerable communities improve their quality of life. At the end of the educational sessions, Educators provided participant women with information and referrals to obtain free breast cancer screening services. A total of 38 courses about health promotion and chronic disease prevention were delivered around Puerto Rico. **Results** A total of 451 participants completed the *Healthy Lifestyles Promotion* course; 1,134 participants received non-formal education about chronic diseases prevention such as cancer, cardiovascular diseases, respiratory diseases, and diabetes; 371 participants received non-formal education about sexually transmitted diseases, dengue and chikungunya and; 1,104 participants acquired knowledge about healthy habits that promote a healthier life. Among the most relevant achievements included:	

		• 585 adopted at least one recommended healthy lifestyle and 445 participants reported to have started some physical activity. • 455 participants started monitoring their glucose levels and blood pressure • 254 participants reported having lowered and maintained healthy blood glucose and cholesterol levels. Extension Educators provided educational activities on breast cancer prevention to 258 women on 25 independent events: • Approximately, half of the participants that have not had a mammography in the past two years accepted being contacted by the PRCCC to receive breast cancer screening tests. • 95% percent of the participants confirmed a positive knowledge increment about topics in detection and prevention for breast cancer. Also, Extension Educators provided educational workshops to public school teachers as a train-the trainer model in order that teachers educated low income families with children with asthma about indoor air quality (IAQ) and asthma management and control. These workshops were conducted in collaboration with the Asthma Program from Puerto Rico Department of Health • 497 school public school teachers received training about indoor pollutants in schools/home settings As part of the PRAES Hurricane recovery initiatives, the Puerto Rico Asthma Program and PRAES developed a guide about	

		hurricane preparedness for people with asthma. This guide was published on the Asthma Program website. **Other information:** http://nebula.wsimg.com/be3e48f7bab55ed17120c7a2ca860a77?AccessKeyId=036DD2B5D5CF18C9F639&disposition=0&alloworigin=1	

23.	Diversifi-cation of 4H Extracurri-cular Educatio-nal Programs and Activities: a PRAES strategy to captivate more children and adole-scents	**What is the issue?** After the 2017 hurricanes, 4-H participants and their families experienced new challenges. Studies have stressed out the importance of youth extracurricular programs as a strategy to reestablish and create new opportunities to strengthen youth development. Assuming our role as an organization committed to promoting positive youth development, we designed a plan of work to empower adolescents to feel stronger and in control of their lives. Guaranteeing safe learning spaces and positive activities to our members was a priority objective. Through our three primary content areas: Citizenship, Healthy Living and Science and using PYD practices, we developed a wide variety of learning opportunities. According to the National Academies of Sciences, Engineering, and Medicine (2020): Adolescence is a period of growth and change. Is "a period of opportunity to discover new vistas, to form relationships with peers and adults, and to explore one's developing identity. It is also a period of resilience that can ameliorate childhood setbacks and set the stage for a thriving trajectory over the life course". **Target audience** Our major target audience were the adolescents, because in the island this group is very vulnerable. For example, 12.1% (16-19 years) are unemployed, out of the workforce and are not enrolled in public or private schools, home schools or	10. Strengthening Youth Life Skills, Leadership and their Community

		other educational institutions. With our educational programs we help 4-H youth adolescents to acquire knowledge and skills to be successful in their transition to adulthood. **What has been done?** We joined our 4-H Youth Health Promoters project with other 4-H projects, activities and experiences in order to expand the opportunities our program can offer to youth as a means to develop life skills and leadership. (e.g., Social Determinants of Health, Ecosystems model, 4-H Thriving Model). We reinforced recruiting strategies to increase the number of teen teachers and youth mentors around the island. We also worked with the Military Kids initiative at Buchanan Base. Together youth leaders, mentors and extension educators at all levels (local, regional and national) reach through non-competitive activities, school enrichment activities, after school experiences, camps, internships', conferences. **Results** Thanks to the combined efforts, we impacted 16,401 participants, of which 595 demonstrated leadership skills, 126 increased their environmental leadership skills and 1,367 demonstrated skills and enthusiasm as team members. Twenty-five 4-H youth leaders assumed leadership roles to coordinate and facilitate the 2019 state summer events, *Agricultural Internship (Coffee), Natural Resources Camp, State Conference, 4-H Bug Camp, Ecology Residential Camp*.	

		The group of 4-H health promoter teen teachers offered 569 voluntary hours to benefit their communities, offering 91 presentations and impacting 1,476 kids and youth in different communities. From these, 1,024 expressed confidence when speaking in front of groups. As a result of the new opportunities created in 4-H clubs, new educational opportunities in Animal Science and Natural Conservation were implemented in our program. These included educational tours to Dairy Farms and Mangrove ecosystems that resulted in the creation of two new 4H clubs. These new 4H clubs were developed in one of the most vulnerable areas of Puerto Rico (Cataño). Participants from this county were able to learn from each other and develop new understanding of worldviews. As a means to measure PRAES impact in our 4H audience, a survey was developed and answered by 493 4H participants: 99% considered 4-H clubs as a safe place to be after class and a place where they can teach others what they have learned; 96% felt that 4H clubs are a place where adults care about them and 95% considered the 4H clubs as a space to do things that you like; 94% feel that 4H clubs encourage you to make plans for your future; and 90% feel that the 4-H program provide opportunities to become a leader.These results are being used to improve our plan of work. **Other information such as relevant websites is optional.**	

		We received the collaboration of the PR Health Department and the Auxiliary Secretary for Health Promotion, SEA-Grant Program, Corteva, US Forest Service- El Yunque National Forest,OAK(Outdoors Alliance for Kids), UPR- Medical Sciences School, PR Tourism Office, National 4-H Council, Walmart Foundation, PR Natural Resources Department for developing our plan of work. They sponsored equipment, health educational materials, Camp and Conference registration, lodging and meals, transportation expenses, and training for youth, volunteers and extension educators. https://www.facebook.com/509700236085642/videos/516390085760824/ https://www.facebook.com/509700236085642/videos/2427256340878069/	

24.	*Home-, School- and Community- Gardens: as resilience strategy against* food insecurity	**What is the issue?** Puerto Rico has a highly vulnerable food supply chain. Home Gardens, School Gardens and Community Gardens are a feasible alternative to increase food security in countries with high density populations and negative net imports, like Puerto Rico. It also can help reduce food shipment times and bring more accessibility of nutritious food. **Target audience** Housewives, Students, General audience. **What has been done?** PRAES personnel trained 1,917 people about the establishment of Food gardens in their communities, schools or homes. In order to provide continuation to these projects, two online pages were developed: "PR Compost" and "Urban Agriculture" where educational material about home, school and community gardens are uploaded and updated periodically. **Results** As part of the achievements of this program, a total of 1,330 home gardens; 49 school gardens and 23 community gardens were established, and 274 people increased their knowledge about IPM in their home garden.	11. Global Food Security and Hunger

		Other information such as relevant websites is optional. CompostaPR https://www.youtube.com/user/compostapr Agricultura Urbana UPRM - https://www.uprm.edu/agriculturaurbana/inicio/	