

Puerto Rico (University of Puerto Rico Mayaguez Campus) Annual Report - FY2021

Report Status: Approved as of 07/14/2022

Contributing Organizations

University of Puerto Rico Mayaguez Campus

Executive Summary

Overview

This annual report includes what the University of Puerto Rico's Agricultural Experiment Station (**PRAEXS**) and Agricultural Extension Service (**PRAES**) consider to be our most salient research and educational achievements during FY2020-2021. Puerto Rico continues recovering from the 2017 hurricanes, the 2020 earthquakes and the persistent effects of COVID-19 pandemic that have tremendously impacted all aspects of life on the island. Progress was achieved while the institution faced the challenges of rebuilding the damage suffered in vital infrastructure facilities, while researchers continued to face limitations in accessing experimentation fields and laboratories, and while Extension Agents and Educators lacked their habitual spaces and methods (face-to-face) to train their clientele due to strict COVID-19 curfews and regulations by executive order. All this was framed in the context of a worsening economic situation that continues to affect the budget assigned to the state university.

In this report we are reporting accomplishments and results from the six Critical Issues defined in the 2021-2025 approved POW which include:

1. Food Security, Plants and Animal Systems
2. Extreme Weather, Natural Resources and Environment, and Sustainable Energy
3. Food Safety, Science and Technology
4. Community, Economy and Sustainable Development
5. Family and Well-Being
6. Positive Youth Development

"**Food Security, Plants and Animal Systems**" is the critical issue that concentrates most of our research and extension projects and programs. Ten research projects were depicted in the issue's summary of progress during the year: nine highlighted in the NRS website and one final report submitted in REEport. Food Security is addressed in the PRAEXS through projects that target stakeholder's concerns regarding lack of seeds to expand plantings, availability of disease resistant cultivars and of prospective profitable new crops, best management practices for the control of pests & diseases, and on improving economic returns to livestock producers through both breeding and best management strategies.

PRAES efforts towards Food Security included the use of high tunnels technology to increase local food production by farmers and urban areas. In addition, integrated efforts among Extension Agents and Family Educators took place to improve agri-business economic and marketing strategies to increase food security in farms, homes, schools, and communities. In terms of animal production, PRAES and PRAEX personnel developed training to help local producers to increase their knowledge regarding recommended management practices and added value of small ruminant meat cuts.

Combined efforts between PRAES and PRAEX plant diagnostic clinics generated important achievements towards the control of crop pests through extensive screening of vegetative samples. Additional efforts between PRAES and PRAEX resulted in the dissemination of best practices to boost the local citrus production.

The "**Extreme Weather, Natural Resources and Environment, and Sustainable Energy**" Critical Issue is also a particularly important research program for the PRAEXS. More than 20% of our total projects contribute to this issue's progress and while the majority are sponsored by non-capacity funds, Hatch funding remains critical for leveraging additional external resources. Five research projects were highlighted that showed progress at addressing problems worsened by the impact of hurricanes, animal waste disposal practices, and

underscoring the importance of assessing and maintaining soil health and quality through best management practices. The PRAES educational activities focused on mitigating the impact of climate change on agricultural production by improving agricultural practices, supporting soil and water conservation, and encouraging composting.

Research projects in the "**Food Safety, Science and Technology**" critical issue continue to help small farmers comply with FSMA regulations that may present a challenge to their operations, while also assisting in the search for alternatives to add value to their products. The three projects highlighted offer significant achievements that also advance the educational agendas of related commodity programs in small ruminants and farinaceous crops. And although the only capacity project currently active in our "**Community, Economy and Sustainable Development**" research program was still in its initial year, prospective activities also promise to advance the marketing strategies for differentiated coffee products.

PRAES efforts towards the "**Family Well-Being**" critical issue focused in promoting family well-being, health and disease prevention, healthy eating, and the management of family resources to improve the quality of life of vulnerable populations affected by earthquakes, Covid19, and other social, economic, and environmental situations experienced in Puerto Rico. PRAES efforts concentrated in empowering communities to reach food self-sufficiency and financial independence. Achievements included the production of action plans for the development of an economic project, generate revenues from the established economic projects and the creation of new jobs.

Through the "**Positive Youth Development**" critical issue, a collection of interdisciplinary 4-H initiatives that focused in creating inclusive spaces for child and youth. Additional projects focused efforts in creating safe learning spaces, establish positive contacts, and provide opportunities and experiences for children and youth as a means to develop skills and abilities to become healthy individuals that positively contribute to our society.

Critical Issue: Community, economy & sustainable development

The educational activities developed focused on the needs of our communities, prioritizing stakeholder's inputs: the development of community enterprises. Projects that empowered communities to reach food self-sufficiency and financial independence, as a means to create vibrant communities, were developed. Achievements included the production of action plans for the development of an economic project, generation of revenues from the established economic projects and the creation of new jobs. The leadership and involvement of the trained leaders was of great benefit since they advise and participate in the community directives and government organizations helping to distribute food and developing community emergency plans for dozens of families in their respective municipalities.

A summary of the overall progress of these projects and the continued education activities related to the community self-management, economic development, and volunteers' resilient program include: participation of 119 leaders with 870 hours dedicated to volunteer work, empowerment and community self-management achieved in 24 communities, collaboration of 56 of organizations to help organizing communities, development of emergency and security plans for 44 families, among other important achievements.

At present, only a couple of Hatch projects contribute towards research in this Critical Issue and they are still in the initial stages of their fieldwork. Progress continues, however, in the planned activities of "Consumer attitudes and behavior towards differentiated products in Puerto Rico: An assessment of text, labels and quick response (QR)codes". This project seeks to increase awareness of the importance of differentiated products to farmers and stakeholders through multiple strategies to present consumers with information about the characteristics of differentiated coffee and milk products.

Critical Issue: Extreme weather, environment, natural resources, and sustainable energy

A series of research projects approved in the aftermath of Hurricane María addressed specific problems that arose as a result of the hurricane. In "Forestry Innovation Laboratory and Learning Institute (FILLI): Using Hurricane Maria's lessons and opportunities to support long-term sustainable forestry industry in PR" the project evaluated the use of soil and growing media amendments from vegetative debris, such as biochar and wood chips on tropical timber tree growth. Results have shown that air dried biochar from different species vary in humidity content from 50% to 10%. Also, *Albizia procera* (white siris) biochar mixed with Promix® in different concentrations showed no significant differences in basil (*Ocimum basilicum*) growth. However, the project's greatest achievement has been the development of the Forestry Innovation Laboratory and Learning Institute (FILLI). This laboratory has served as an outreach venue where the research content material is adapted to a Spanish-speaking audience to promote the production of timber trees and the use of hardwood materials. The project has gained greater reach thanks to collaboration with PRAES, with other NIFA programs such as RIIA and McIntire-Stennis and with other federal agencies such as the Forestry Service.

"Using wild bee hives to assess melliferous plants, honey bee health and honey quality", a second project borne after hurricane María, deals with the conservation, restoration and maintenance of honey bees. Since 2019, we have worked on establishing apiaries at the different locations of PRAEXS. At present, Lajas, 3 established from a total of 17 relocated; Isabela, 5 established from a total of 13 relocated; Juana Diaz, 4 established from a total of 8 relocated; Gurabo, 2 established from a total of 6 relocated; Adjuntas, 9 established from a total of 12 relocated; Corozal, 5 established from a total of 17 relocated. A beehive registration sheet was developed to make field assessments of each established beehive and to describe temporal changes of the apiary health and honey production. Field variables measured at the beehive: amount of honey, nectar, pollen, queen sightings, population size, types of queen cells, drone population, temperament of the colony. The results of this research project will increase awareness about bee conservation and importance over agricultural production areas among the general public.

In the last few years soil quality and health have been two of the most important research subjects in the PRAEXS. "Soil quality assessment among soil orders and ecological zones in Puerto Rico" was developed to directly focus on establishing quantitative parameters to distinguish soil quality among soil orders, soil series and ecological zones in the tropics. At present, soil quality parameters have been established for two soil series (Coto and Cotito) of the Oxisol order. The Coto soil has shown soil quality parameters superior to the Cotito series. Cotito soil has the limitation of being shallow and moderately alkaline while Coto soil is slightly acidic with excellent physical properties. With the results of this project, it will be possible to assess the best management practices and techniques to predict short- and long-term impact on land use, determine soil, water and air health. Among the management practices that could be recommended is the use of cover crops. Cover crops have been widely used in the US for some time but in PR only recently this practice has gained popularity. Even when this is a positive practice, we have been using plant species and planting rates and densities recommended for temperate zones. "Agroecological Practices Adapted to Extreme Weather Conditions" introduces the use of cover crops to measure the improvement in soil health of acid and eroded agricultural soils of the central region of PR. After hurricane María it became abundantly clear that we needed to take proactive steps to protect our soils of the damaging effects of extreme weather conditions. This project initiative, in conjunction with other federal agencies such as USDA-NRCS, will aid in implementing tailored soil conservation practices to conserve our soils and guarantee the income of growers in the short- and long-term.

Finally, "Towards a sustainable Hog production in PR" is the only research capacity project we currently have contributing towards energy recovery from animal waste treatment thru biological decomposition. This project has the potential of reducing the carbon footprint of small and medium size swine operations in Puerto Rico.

PRAES educational activities were focused on mitigating the impact of climate change on agricultural production by improving agricultural practices, supporting soil and water conservation, and encouraging composting. Multiple workshops covering soil sampling, soil analysis interpretation, and nutrient recommendations were provided for the agricultural agents as a means to improve their technical knowledge. Trainings on soil management and fertility were offered to farmers which included the analysis and interpretation of their farm soil samples. Collaborations between the PRAES and NRCS resulted in the dissemination of soil nutrient management information to farmers, producers, and the public. Collaborative efforts with PRAEX resulted in trainings on soil fertility and nutrient management to agricultural agents about vegetable crops (*solanaceae* and cucurbits). Workshops on watershed protection, water harvesting, and storage have been offered to farmers to increase on agricultural resilience and natural resource protection. Moreover, workshops on the developments in tropical agriculture in drought conditions was provided to individuals using the established PRAES curriculum guide "Climate Change: Impact on agricultural production and methods of adaptation". The educational activities related to soil management and conservation resulted in the adoption of practices and recommendations that have improved the conditions on more than 50 farms; 8 farmers incorporated the use of soil amendments based on soil fertility results; 11 farmers changed their fertilizer formulations to more closely coincide with the needs of the crops grown and 37 individuals adopted recommended conservation practices to effectively manage the soils on their farms. Trainings related to agricultural resilience and natural resource protection resulted in more than 20 individuals/farmers that adopted practices that will improve agricultural resilience and natural resource protection; 15 individuals implemented or improved water collection systems on their properties while one farmer adopted agroforestry practices and 5 Five farms prepared contingency plans and obtained agricultural insurance in case of natural disasters. Trainings on composting at home resulted in 5 families now composting materials from their kitchens to provide nutrients to their home gardens and 3 farmers also adopted composting practices on their farms in the reuse of crop residues.

Critical Issue: Family well-being

Socioeconomic statistics report an increase in the number of people who have lost their jobs which in turn has caused financial instability and food insecurity; uncertainty, infliction of sadness and pain; stress in interpersonal and family relationships; poor care of health conditions, and other related situations. The Healthy and Sustainable Families program aims to promote family well-being, health and disease prevention, healthy eating, and the management of family resources to improve the quality of life of vulnerable populations.

Through multiple educational strategies such as short courses, educational series, workshops, and virtual and face-to-face activities, the Family and Consumer Sciences Extension Educators, and their volunteers, achieved the programs goals. Individuals and families increased their sense of well-being through non-formal education on related topics, and the application of skills and practices to improve self-care and self-esteem, managing emotions, human relationships and positive family, healthy lifestyles, disease prevention, nutrition, food safety and food security. In addition, participants acquired acquisition of knowledge for the management of family resources to improve their economic and social condition.

Our target audience included adults, older adults, caregivers, families, and communities in rural and urban areas, residents of public housing, participants of non-profit organizations, school youth, and other low-income audiences. In summary, the benefits of the project included: the collaboration of 262 volunteers. Participants reported to improve: their family's quality of life (n=53), roles and duties as fathers, mothers, or caregivers (n=39), family strength skills such as sharing time, improving family bonds and affection, effective communication, commitment, and spirituality (n=355), skills to strengthen their personal development and well-being (n=271) and, food security through food preservation using (n=777), among other achievements.

Critical Issue: Food safety, science and technology

Our current POW depicts how part of our research and education efforts will be directed towards identifying small farmers in need of water sampling to comply with the Food Safety Modernization Act (FSMA) Produce Safety Rule, and in conducting water sampling on their farms. Work conducted last year under collaborative project "Enhancing Microbial Food Safety by Risk Analysis" took water samples of wells, surface and municipal waters in 12 farms of southwest Puerto Rico, and shared results and recommendations with the farmers. In addition, research and development of new products that could potentially add value to local farinaceous crops has been advanced by the results obtained in "Elaboration of flours, extruded products & chips based on *apio* (*Arracacia xanthorrhiza* B.) & plantain as alternatives for using local agricultural products & their marketing". This project demonstrated that *apio* can be extruded and used as a high quality snack. Finally, the project "Manufacturing and marketability of valued added products using goat milk" contributes both to this Critical Issue and to the work needed to address Animal Systems concerns in small ruminants' farms and enterprises. Under this project progress has been made on the development of *cajeta* (slow-cooked caramel sauce made of goat's milk), yogurt and a frozen dessert, and is currently focusing on performing proximate analysis of milk to make formulations suitable for manufacture of these products.

PRAES is not reporting this year.

Critical Issue: Food security, plant & animal systems

Puerto Rico continue to lose its more productive farming lands, risking our Food Security. PRAES County Agents (**CA**) and specialists provided individual assistance and training to farmers on crop and animal production, organics practice, farm management, feasibility analysis and marketing networks. In addition, PRAES Family Educators (**FE**) also delivered individual assistance and training to housewives, young people, and public about increase food security practices, like home, school and community gardens. Educational activities carried out included training on food security activities to adults and youth, home and community gardens activities and training of farmers about agricultural enterprise feasibility and marketing strategies. Training provided to small farmers about urban agriculture and high tunnels, to promote the organization of communities and farmers to increase local food production, included the participation of CA, FE and NRCS agronomists. Achievements included the training of more than 250 farmers and 100 community leaders and the establishment of 11 high tunnels incentivized by NRCS.

Small ruminant production is a viable strategy to increase local food production since they exhibit a great adaptation to tropical conditions. Educational activities that increase the public interest in small ruminants, their demand and production efficiency will help increase food security and the agricultural activity of Puerto Rico. PRAES and PRAEX personnel developed training trained producers to increase their knowledge on management practices and added value of small ruminant meat cuts. Associated with these efforts, one participating farmer opened a meat-processing plant facility to produce specialized meat cuts. Major activities employed to increase the interest of the public about small ruminants, and efficiency of production of small ruminant systems, have benefited over 200 participants.

Plant disease outbreaks in Puerto Rico cause significant losses in cash crops, fruit, and ornamentals. Coffee and vegetables production, specifically in the southern area, are currently experiencing outbreaks of fungal, bacterial, and viral origin. Diagnostic tools for plant disease are of vital importance to implement an effective management strategy. The PRAEX and PRAES Diagnostic Clinics have processed more than 1,370 vegetative samples from more than 30 different crops and ornamentals. Information dissemination has been focused on agricultural festivals, scientific meetings and interventions with farmers and communities about the different diseases and pests. These activities have encouraged more than 75 producers to adopt recommended practices related to cultural, biological, and chemical control of pests in crops.

Citrus production in PR is of paramount importance, not only for farmers but for the local markets and households. The citrus industry has been severely impacted by two important diseases, Huanglongbing (HLB) and Citrus Tristeza Virus (CTV). To overcome this, the Adjuntas Experimental Station has improved its citrus nursery facilities. PRAES efforts included training of 85 CA and 24 agronomists from the Department of Agriculture. They in turn provided training to growers and interested individuals to help disseminate good agricultural practices to enhance citrus production, training 596 individuals. As a result of PRAES educational intervention with citrus growers, producers reported to adopt practices that promote production efficiency, quality of their products by adopting practices related to sustainability, increase production and business size.

Research efforts continue to target the most important production constraints faced in crops essential to our food security and economic viability of local farming. Under "Plant Genetic Conservation and Utilization" we continue to evaluate local and introduced germplasm to identify desirable traits and genotypes with high agronomic performance. In bananas for ex., the evaluation of cvr. Monalisa (FHIA02) shows it could be an alternative if Fusarium TR4 enters the Caribbean, potentially also providing an alternative market for the population with diabetes, given its lower glycemic index than Cavendish Grande Nain. Work with legumes have been strengthened through collaborative research efforts in "Breeding Phaseolus Beans for Resilience, Sustainable Production, and Enhanced Nutritional Value" and under "Evaluation and selection of grain legumes genotypes with heat and drought tolerance in Puerto Rico". Varieties released through the former project contribute to reduce loss in yield and seed quality caused by disease, and permit more bean production during the hot and humid summer months. In the latter, several genotypes were identified that overcome drought.

New production systems offering market alternatives to farmers are also being explored in "Adaptability and Performance of Specialty Tomatoes and Asian Vegetable Varieties in Different Production Systems in Puerto Rico with Market Opportunities", while under "Facilitating Registration of Pest Management Technology for Specialty Crops and Specialty Uses" research seeks the best management tools to diminish the impact of pests and diseases particularly in minor crops. These crop protection efforts were complemented by activities developed in "Design and evaluation of protocols for early detection and management of plant pathogens". Under this project a Loop-mediated isothermal amplification (LAMP) assay for the early detection of *P. fijiensis* (responsible for Black Leaf Streak in plantains and bananas) was developed to be used in Puerto Rico and help prevent the spread of the disease.

Heat tolerant dairy cattle and enhancing lamb and beef production are major concerns for livestock production in Puerto Rico. Highlighted projects in heat tolerant dairy cattle, "Implementation of novel reproductive biotechnologies and genomics for the multiplication and commercialization of genetically superior Slick cattle" and "Characterization and relationships of growth patterns, eating behavior and health in slick and wild type (WT)- haired Puerto Rican Holstein calves and heifers" show continued progress in the depiction of Slick cattle vs WT in different parameters. Research efforts have shown greater thermoregulatory and productive capacities in these animals when compared to WT. This response has been observed in the early stages of life in these animals.

The evaluation of nutritional and management strategies aimed at improving beef and lamb production for human consumption in Puerto Rico is also a current need. In "Performance, health, carcass and meat quality, sensory attributes, and consumer preference of lambs reared under thermal stress in grazing and feedlot conditions and slaughtered at two body weights", results showed that the feeding system affected performance, carcass and cuts yield, and meat quality of crossbred lambs raised under heat stress conditions. As a result of the PRAEXS research and PRAES efforts, an increase in the offer of meat lamb cuts have been observed on the island. Research efforts to enhance beef production include the "Effect of sex, nutritional plane, and processing age on the growth efficiency, carcass composition, beef quality and economic returns of Senepol calves raised under grazing conditions" (final report in REEport). 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. This practice has been adopted for beef producers on the island.

Critical Issue: Positive youth development

The recent natural disasters and the current health crisis of Puerto Rico have dramatically impacted youth's mental health and academic achievements. The lack of educational opportunities and access to healthy food, due to the closing of schools, in addition of the pre-existing economic challenges exacerbates our youth precarious situation. The Positive youth development program used interdisciplinary 4-H initiatives to integrate 4H members needs and program objectives to develop skills and abilities that promote healthy lifestyles. Examples of some of the 4H activities implemented to achieve the program goals included:

- ***Reto Agrícola*** (Ag-challenge), a virtual and at-home learning initiative that connected our children and youth with experiences in agriculture.
- The ***Ruta 4-H para una vida saludable*** initiative (4H route for a healthy life), through school and community teen teaching strategies, allowed us to teach and promote healthy living lifestyles to empower youth.
- "Talent is everywhere opportunity is not", **OYE** provided new opportunities to our participants to create awareness about deaf and blind youth in the island and how 4-H can be an inclusive place with opportunities for development the talent and life skills of this

community.

- **ACCESO 4-H** activities served as a space to reflect and talk about homelessness and their impact in youth, people, and families.
- The **Bug Camp** exposed kids and youth to basic knowledge in entomology. They learned about related professional careers in entomology and the role of insects in the food production, how they increase environmental diversity, and their impact in reducing world hunger.

Virtual camps, forums, 4-H week and state conferences were activities in which youth improved their leadership skills and teamwork strategies. All the activities included advocacy, emergency preparedness, diseases prevention and other approaches like 4-H DEI objectives and SDGs, that provided knowledge and community service experiences for youth to develop skills and abilities to become healthy individuals (*i.e.*, physically, socially, mentally, and emotionally) that positively contribute to our society.

Merit and Scientific Peer Review Processes

Updates

No significant changes have yet occurred in the PRAEXS merit review process but two suggestions are being discussed and implemented to guide future changes in this process and in the way it may assess and incorporate stakeholders input: (1) a committee with participants from the PRAES, PRAEXS and CAS teaching faculty has been established to evaluate prospective changes in the way research priorities and programs are established and developed, and (2) the incorporation of research and commodity programs leaders into PRAES regional advisory committee's meetings is being evaluated as a means of putting researchers more directly in contact with the needs expressed by farming stakeholders. Results from these initiatives will be reported in future Plans of Work.

Stakeholder Input

Actions to seek stakeholder input that encouraged their participation with a brief explanation

None

Methods to identify individuals and groups and brief explanation

None

Methods for collecting stakeholder input and brief explanation

A new strategy was adopted in FY 2021 for PRAES. All the data collected from extension county advisory committees was recorded digitally through online surveys. This allows us to interrupt the stakeholder input process during COVID-19 and improved the monitoring of needs at the municipality, regional and state level. This new approach improves the collection process and participation of stakeholder input, allowing extension administratives to better distribute time and effort in the required programs.

None yet in research but please refer to the description above of alternative methods for merit review and collection of stakeholders input being evaluated

A statement of how the input will be considered and brief explanation of what you learned from your stakeholders

Stakeholder input was considered in the list of priorities selected for last year's Hatch competitive call for research proposals and for the distribution of time and effort among the PRAES Educational Programs. It also guided the search for the limited research and teaching positions opened in the CAS during this year.