

# Puerto Rico (University of Puerto Rico Mayaguez Campus) Annual Report - FY2022

## Report Status: Approved as of 06/30/2023

### Contributing Organizations

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University of Puerto Rico Mayaguez Campus

### Executive Summary

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#### 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 FY2021-2022. As the island continued to battle the pandemic and its dire social and economic impacts, Hurricane Fiona struck Puerto Rico in September 2022 again causing widespread damage and disrupting power and water service for nearly two weeks after the storm. Many research labs and field experiments were affected, and research and extension faculty had to readjust their projects and programs plans to meet the new reality. Moreover, the University's fiscal situation remains challenging, triggering dozens of employees to resign and limiting the hiring of new faculty and non-faculty appointments needed to strengthen our programs and accelerate recovery efforts.

Despite these limitations and setbacks, progress has been achieved in priority research and extension programs for Puerto Rico's rural economy. As a recent ERS publication depicts, "coffee farming has remained a dominant land use and an important source of economic activity for thousands of farmers in the central highlands of the island, providing employment to thousands of hired workers" (USDA-ERS, AP-114, April 2023). A focal point of our combined research and extension strategy is to strengthen a specialty coffee producing sector. Accordingly, highlighted research results this year include economic studies of the differentiated coffee market, attention to the phenotypical characterization of coffee rust resistant varieties, and experiments with innovative processes to aid with coffee processing and produce new value-added products. Given the recurring impacts of drought in PR, recent microirrigation research has integrated coffee into the crops being studied. Extension results also underscore continuing efforts to provide tools to enhance coffee quality and marketing opportunities to promote competitiveness and economic benefits to our farmers.

In terms of animal production, combined efforts between PRAES and PRAEX have been concentrated at improving the bovine productive efficiency by evaluating neonate feeding strategies that result in optimal development. Additional efforts of PRAEX and PRAES included the evaluation of improved tropical forage species, destined to feed cattle, that result in the best economic benefit to our farmers. The factors considered in this study included the best agronomic management practices to produce improved forages considering the different agroclimatic regions of Puerto Rico.

This report includes accomplishments and results from the following six Critical Issues defined in our 2022-2026 approved POW:

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**" continues to be the critical issue that concentrates most of our research and extension projects and programs. Results from ten research projects, three of which are in collaboration with extension, drive the progress reached in this issue during the year. 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, plant varieties better adapted to organic systems, and on improving economic returns to livestock producers through both breeding and best forage and overall management strategies.

PRAES efforts towards Plant Systems focused on adding value to the coffee produced in Puerto Rico. Educational activities and follow up visits were centered in providing producers the adequate management practices at the pre- and post-harvest level to improve the quality of their coffee. Additional training provided recommended marketing strategies to improve their competitiveness in the market and generate an economic benefit. In animal systems, combined research and extension efforts to characterize the slick haired phenotype in the *Bos taurus* dairy breeds have also continued.

The "**Extreme Weather, Natural Resources and Environment, and Sustainable Energy**" critical Issue is also a particularly important research program for 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. Four research projects were highlighted that showed progress at addressing problems worsened by the impact of hurricanes, the occurrence of algae blooms in water reservoirs, and underscoring the importance of assessing soil conditions and sustainable technologies for crop intensification such as microirrigation. One PRAES program was highlighted that continued focusing on

mitigating the impact of climate change on agricultural production. Among the most salient activities included train the trainer workshops to extension agents around the island and collaboration with NRCS to expand the dissemination of soil nutrient management information to farmers, producers, and the general public.

Research projects in the **"Food Safety, Science and Technology"** critical issue continue to monitor food safety issues that that may present a challenge to small farmers operations or a human health hazard, while also assisting in the search for alternatives to add value to farm products. This year's highlighted results show progress achieved in value-added alternatives for coffee, plantains, apio and goat milk. The Food Safety program of Extension continues providing courses to our audience on recommended food preservation practices, mainly to housewife, and the Food Safety Course to people in charge of food establishments.

Although our **"Community, Economy and Sustainable Development"** research program had several new projects starting this year, only one had significant results to highlight related to specialty and differentiated products as strategies to improve the economic situation of coffee and milk operations. Pertaining to PRAES activities, progress was achieved and highlighted under the community self-management, economic development, and volunteers' resilient projects during critical times program. During this period, the program activities focused on improving the capacity of our audience in producing their own food and generating income-producing alternatives that can significantly increase the recovery prospects of its communities.

Within the **"Family Well-Being"** critical issue, PRAES highlighted important progress through the existing Healthy and Sustainable Families Program. For this period, PRAES activities towards the goals of the program centered efforts in establishing alliances with several health-related organizations to expand the impact of our work. Efforts concentrated in educating women of 21 years of age or older about health, prevention and early detection of breast and cervical cancer.

Through the **"Positive Youth Development"** critical issue, a collection of interdisciplinary 4-H initiatives focused on creating inclusive spaces for child and youth. A new program was included for FY2022 that addressed efforts to help overcome the lack of educational opportunities and access to health services and food, which were exacerbated by the closing of schools. Through the Teens leading the change for community wellness program, PRAES provided access to fresh food and promote wellness to youth that are prone to homelessness.

#### **Critical Issue: Community, economy & sustainable development**

As depicted in our POW research efforts continue to focus, among other priority areas, on marketing strategies that could improve the livelihood of farmers and on providing the data needed to better tailor agricultural policies towards this goal. The potential of specialty and differentiated products, as strategies to improve the economic situation of coffee and milk producing farms, has been explored during the last decade and important conclusions on consumers preferences are now available to inform these industries marketing strategies. In the case of milk, results indicate that education, age, and gender of consumers affect their concern for animal welfare in their buying decisions. Results suggest that a marketing strategy for milk produced ensuring animal welfare can be directed towards women, the youngest and the most educated, since they were the most interested in this product. In the case of coffee, studies have found that consumers are willing to pay a premium for differentiated coffees in Puerto Rico, and that they prefer texts and logos over quick response codes to access the product's characteristics on the coffee bag. Highlighted project results include publications summarizing these conclusions.

PRAES activities pertaining to community, economy & sustainable development critical issue focus efforts in educating communities so that they can meet their needs and take actions to improve their quality of life through community empowerment and self-management. Some of the advancements pertaining this critical issue for FY2022 included 1) a total of 252 community visits that resulted with 451 interviews made to community members to identify basic community needs, 2) 32 courses offered on principles of organization, self-management and community empowerment benefiting 128 people and, 3) the collaboration of 56 governmental or non-governmental organizations with PRAES in the development and organization of communities. In turn, 39 communities were organized and 22 established a community project in collaboration with other Extension educational programs (4H, Agriculture or Family and Consumer Sciences) to solve one or more of pre-identified needs.

PRAES continue investing in our leaders to increase our impact and achievements. A total of 393 volunteers were trained in leadership and PRAES programs giving in return 433 hours of volunteer work as community leaders.

New progress was achieved under the Community self-management, economic development, and volunteers' resilient projects during critical times Program (CSM). Activities continue aiming to promote income-producing alternatives to increase the recovery prospects of our communities and improve their food security. Two awards were obtained that boosted the impact of this program, incorporating more than \$75,000 to build the necessary infrastructure. These fundings were used to educate community organizations about agroecological systems as a resilient management strategy and community enterprise, and to organize educational centers to train communities about aquaculture systems and marketing. As part of the CSM program result include the participation of 78 leaders in the design and development of their communities generating a total of 245 volunteer hours, 23 communities made progress in meeting their quality of life, 10 action plans were developed or updated by community members to address a problem and 2 communities were organized for the preservation and conservation of coastal resources and other natural resources.

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

One of the perils of production agriculture is the potential for surface and groundwater contamination due to excess fertilizer and/or soil amendment runoff. Even with good soil and crop management practices nutrient enrichment to surface and ground water could occur. One of the most pressing freshwater quality threats for future generations is the emergence of hazardous algae bloom. Algae blooms can have severe consequences on human health and on the environment. Nutrient enriched reservoirs as a result of runoff and erosion can be responsible for an increase in vegetation on the water surface. Project PRH-479, initiated in the aftermath of hurricane María, evaluated the use of drone-based sensors to monitor the incidence of

phytoplankton productivity in two reservoirs of Puerto Rico. Field bioassays were also used to evaluate the influence of nutrients and dissolved inorganic carbon on phytoplankton productivity. Results at Cerrillos reservoir showed that phytoplankton responded similarly to nitrogen and Phosphorus in increasing its productivity, however, no difference was observed to nitrogen source. Biomass productivity followed a logarithmic response with saturation values reached at elevated nutrient concentrations. In addition, increases in chlorophyll *a* has increased the trophic levels from oligo-mesotrophic condition of the Cerrillos reservoir to eutrophic levels. These results indicate that preventive measures need to be reinforced to prevent additional nutrient enrichment.

The area extent of saline soils in Puerto Rico is less than 2%, however, most of the soils in the area are quite productive when managed properly. One of the most important agricultural areas is the Lajas Valley Agricultural Reserve, which encompasses an area of over 40,000 acres primarily Vertisols, with irrigation-drainage infrastructure. Project PRH-483 was developed to update the distribution and extent of soil salinity in this area since that last time it was evaluated was in the 1950s. The results indicate that the area surveyed was 67% normal, 27% saline, 0% sodic and 4.3% saline-sodic. A comparison of these results to those from 1958 showed that 42% of the soils were normal and did not change, 7% of the soils were changed to normal, 3% of the soils changed from sodic to normal, 10% of the soils that were normal became saline, and 16% of the saline-sodic soils changed to normal. An overall increase of 18% of the soil area previously affected by excess salts changed to normal. These results show the efficiency and importance of soil and irrigation water management in saline soils.

Puerto Rico has been part of the multistate W-4128 (PRH-402) project for irrigation for many years. Throughout the years many forms and techniques of irrigation have been evaluated on different crops. Recently, climate change has had a significant effect on precipitation patterns in PR, specifically, an increase in drought periods. One of the most important crops in PR agriculture is coffee. These changes in precipitation patterns have focused the research in irrigation to the mountainous region where most of the coffee production is concentrated. Microirrigation levels were evaluated on coffee (Var. 'Catuai') yield to gather data and make recommendations regarding the use of drip irrigation for coffee plantations for the humid region of PR. While results showed no significant differences among drip irrigation treatments for the first year, data is been collected for a second year.

Finally, forestry research and outreach continue to progress hand in hand with Para La Naturaleza, an NGO dedicated to the conservation and reforestation of protected ecosystems. The results of project H-489 on how to use biochar will directly help on possible new formulations of growing media that include less amount of Promix. In addition, the data generated on the test of biochar in the field will help them improve their reforestation strategies.

Under this critical issue, PRAES aims efforts to improve resilience and response to extreme climate changes while maintaining productivity and protecting vital water and soil resources. The most salient educational activities of FY2022 included: 1) 24 people trained in collecting, storing, and re-using rainwater for agricultural purposes, 2) 31 people trained in fire prevention in forests and pastures, 3) 19 people trained in natural disasters and emergency management to reduce losses and maintain the operation of their farms. Of the people that were instructed in these topics, 15 reported adopting at least one of the recommended practices offered by PRAES personnel.

Achievements pertaining to the natural resource protection amid extreme weather and natural disasters program were highlighted under the new results (Mitigating the impact of climate change on agricultural production by improving agricultural practices, supporting soil and water conservation, and encouraging composting). A series of train the trainer workshops (n=6) were offered to extension agents covering soil sampling, soil analysis interpretation, and nutrient recommendations were provided. In turn, the county agents provided 15 trainings to 75 farmers on soil management and fertility. Soils from 30 farms were sampled and analyzed and results discussed with farmers providing the appropriate recommendations. New collaborations between PRAES and NRCS boosted the dissemination of information on soil nutrient management information to farmers, producers, and the general public. Some of the most important achievements of this program include the adoption of practices and recommendations that have improved the conditions on more than 45 farms, 11 farmers incorporated the use of soil amendments based on soil fertility results, 8 farmers changed their fertilizer formulations to more closely coincide with the needs of the crops grown and 52 individuals adopted recommended conservation practices to effectively manage the soils on their farms.

Other achievements of this program include the emergence of a new eggplant farmer in Isabela, PR. This farm was originally producing forages destined to feed cattle; however, it was not generating appropriate benefits to the farmer. After several visits, training, and recommendations from PRAES the farmer was able to reduce his fertilizer application by 75% while maintaining vegetable production. Through follow-up visits the farmer also learned about the importance of plant nutrition, how to read soil test results, how to recognize beneficial insects and practices to control plant pests. The farmer is currently in the process of starting a second farm.

#### **Critical Issue: Family well-being**

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. During FY2022, this program centered its efforts on educating our audiences about women's health and early detection of breast and cervical cancer; highlighted under the Health, Prevention and Early Detection Breast and Cervical Cancer Results. To expands Extension non-formal education to populations that lack access to information and educational services for prevention and early detection of cancer, PRAES Family Consumer Sciences established a collaborative agreement with the Puerto Rico Breast and Cervical Cancer Prevention and Early Detection Program (**PRBCC**). Educational activities on breast, cervical, colorectal, and other types of cancers were offered to 1,315 people in Puerto Rico. Topics presented to our audience included 1) identification and referring of women of 50 years of age or older who have not had a mammogram in the past two years to the Comprehensive Cancer Center and, 2) identification and referring of women of 21 years of age or older who have not had a Pap smear in the past three years; have no health plan; and that they are residents of the municipalities of the southwest region. Of the 1,315

people who received non-formal education, 488 women reported to recognize the importance of prevention and early detection of breast and cervical cancer and 15 women, without a health plan, were referred to the PRBCC. Particular attention was offered the southwestern region of Puerto Rico, which has the highest number of uninsured women, canalizing an early detection test to all 195 participating women.

#### **Critical Issue: Food safety, science and technology**

Research in this area continue to concentrate in strategies to add value to our crops and livestock commodities. Final results available from a project on the elaboration of flours, extruded products and chips from *apio* (Arracacia xanthorrhiza B.) and plantains show that Arracacia and plantain flour have attractive properties and can be used as an alternative for the food industry. Arracacia starch isolated from the rootstock had the lowest eGI (48.62), when compared with that stored in the root and stem, indicating starch rootstock is a low eGI food and a good dietary carbohydrate alternative for diabetic people. Work performed also demonstrated that *apio* can be extruded and used as a high-quality snack. The general acceptance of the apio snack was from 6 to 9 on a 9-point scale which corresponded to 70% of the panelists. Also, results from a survey of consumers preferences related to fresh or processed apio and plantains products provided some insights on which of these processed products have the most market potential in Puerto Rico.

In the case of goat's milk, an emerging niche market in the island, work on the development of *cajeta* and yogurt is on its final stages. The process confirmed that products made with goat's milk tend to have softer texture, and formulations used for cow's milk may not work for products with goat's milk. With the information gathered researchers are planning to offer short courses to all the dairy goat farmers that may be interested. Lastly, two projects are now addressing the coffee industry's efforts of regeneration based on specialty coffees and value-added products. In the highlighted "Controlled Fermentation Studies in the Manufacture of Specialty Coffees", experiments were done to evaluate the capacity of mucilage removal by selected commercial yeast strains. Results obtained so far showed that the yeasts used, by themselves, are not able to remove the mucilage, evidencing the need of other microorganisms to perform this function. Although the project is still in its experimental stages, we expect that the project activities will generate methodologies and procedures that will help to improve the quality and marketability of specialty coffees cultivated in Puerto Rico.

The PRAES Food Safety program trained all the Puerto Rico correctional administration personnel about proper management of food storage and expiration dates. Thanks to this training the correctional administration was able to update their guide of food handling standards and procedures for all the jails of Puerto Rico. All the Family Science and Consumer Educators were trained about recommended practices in dry storage and in turn, a total of 10 online courses were offered to the public in general.

#### **Critical Issue: Food security, plant & animal systems**

Research efforts to increase crop production for local consumption continue to focus on the supply of quality seeds and planting materials and on the management of key pests and diseases. The most important commodities in Puerto Rico for local consumption are bananas and plantains. The demand for tissue culture seedlings is growing and research into resistance to major diseases has resulted in the selection of banana FHIA02 (Monalisa). This variety is also a good alternative for organic production due to its desirable agronomic characteristics. For root crops such as sweet potato, yam, taro, tanier, white carrot (*apio*) and cassava, which depend on vegetative seeds, activities focused on the production of disease-free vegetative material. Protocols for yam (*Dioscorea rotundata*) have been tested and the results have been validated under field conditions. The initial phase to produce disease-free seed of yam cv. *Guinea Negro* was completed using a Temporary Immersion Bioreactor System and the protocol was validated. Producers have been trained in the process of selecting high-quality seed and post-harvest storage and pathogen management.

Avocado and breadfruit are also crops with strong consumer demand in PR for which there is ample room for growth to substitute imports. Research results on the combined effects of fertilization and phytoestrogens on the growth and yield of these crops can help growers decide which practices are best suited to their interests and may help reduce wasteful and potentially polluting use of fertilizers in these crops.

A major goal of the UPR bean breeding program is to develop locally adapted bean cultivars that can be used to increase food security. An important source of vegetable protein are common beans and pigeon peas. Germplasm releases of UPR-Mp-23, UPR-Mp-34, UPR-Mp-42, and UPR-Mp-48 were achieved, with improved resistance to *Macrophomina phaseolina* for use in breeding programs. In common beans as well, three QTL on chromosomes 3, 7, 9 were identified to confer resistance to *M. phaseolina*. Markers have been used to identify genes/QTLs associated with biotic and abiotic traits in Phaseolus genotypes. Also, alternative strategies of control of Lepidoptera species, major pests in pigeon pea and sweet corn, using biological agents alone and in combination with low toxic synthetic insecticides were evaluated.

Regarding pigeon pea breeding, a new pigeon pea cultivar '*Isabella*' with higher yield and early maturity was released. White bean cultivars '*Bella*' and '*Beníquez*', released by the UPR-AES, expressed high levels of resistance to root rot caused by *Fusarium solani*. The Mesoamerican pink bean line PR1519-25 has multiple virus resistance, erect plant type and a mean seed yield > 2,500 kg/ha over seven planting dates. It was released as '*Rosalinda*'. Snap bean, black, small red, red mottled and yellow bean breeding lines with multiple virus resistance have been selected.

Finally, plant varieties better adapted to organic systems have been already identified and recommended to organic or agroecological farmers. A preliminary profile of PRAEXS organic farms stakeholders was prepared and presented in an international social science conference.

Progress has also been achieved in the strategies adopted to increase animal production in warmer climates through the study of a slick hair phenotype and through the evaluation of tropical improved grasses. In Puerto Rico, dairy cattle carrying a slick hair gene appear to be an adaptation of cattle to heat stress conditions. Improving knowledge of the Puerto Rican slick-haired cattle is essential for precise selection of animals, and subsequent increase in efficiency of milk on dairy farms.



Previous studies on the characterization and relationships of growth patterns, eating behavior and health in slick and wild type haired Puerto Rican Holstein calves and heifers have shown greater thermoregulatory and productive capacities of the slick haired phenotype cattle compared to the wild type. Current research and extension efforts include the evaluation of using an automated milk feeder to deliver an accelerated growth feeding protocol on the weight gain and future milk yield in slick and wild-type Holsteins calves.

Experiments have been performed on estrus and pregnancy rates and ovarian steroid concentrations after estrus synchronization and throughout pregnancy, and to determine if gene expression differences exist in the liver of slick hair and wild type heifers. Preliminary results show there are detectable differences in gene expression that may indicate that the slick cow is more fertile than the wildtype when exposed to tropical warm weather.

Studies of the performance of improved forage species in local environments already have results that have been used by Extension to provide specialized technical advice to farmers. The best grasses varieties have been identified for the different agroclimatic regions of Puerto Rico. The best soil preparation techniques, amount of seeds per acre and fertility recommendations, have also been developed based on research results.

PRAES efforts continue focusing on educating our farmers and ranchers through traditional and non-traditional educational activities to improve the quality of their products through the proper management practices that contribute to increasing production, competitiveness, efficiency, and biosecurity in their enterprises. Pertaining to Animal Systems, a total of 111 educational activities were provided to ranchers with 948 people benefiting from these and 75 reporting to adopt at least one recommended practice. In the last years, an increased interest in bee keeping has been observed and reflected by the increased number of educational activities in apiculture (i.e., 33.3 % of the total trainings under animal production). The proportion of educational activities in beef and dairy cattle reached 31.5 and 19.8 % of the total activities in animal systems, respectively.

Although PRAES did not report significant progress in the defined NRS Extension programs, progress was achieved in joint efforts with PRAEXS. Examples of this included research and outreach about neonate feeding strategies to improve bovine productive efficiency under tropical conditions. Additional efforts included evaluation of improved tropical forage species, destined to feed cattle, that result in the best economic benefit to our farmers. Among the factors considered in this study included the best agronomic management practices to produce improved forages considering the different agroclimatic regions of Puerto Rico.

Regarding Plant Systems, a total of 141 educational activities were provided to farmers with 4,168 people benefiting from these and 250 reporting to adopt at least one recommended practice. Vegetables, farinaceous and non-citrus fruits continue to be the areas most demanded for training, accounting for 72.34% of all the educational interventions provided to our farmers For FY2022, a new PRAES program was created and focused on adding value to the coffee produced in Puerto Rico. Educational activities and follow up visits were centred in providing producers the adequate managements practices at the pre- and post-harvest level to improve the quality of their coffee. Additional training provided recommended marketing strategies to improve their competitiveness in the market and generate an economic benefit.

#### **Critical Issue: Positive youth development**

Prior to the pandemic, youth of Puerto Rico were struggling with challenges related to poverty. Moreover, the pandemic dramatically impacted youth's mental health and academic performance. The lack of educational opportunities and access to health services and food, mainly due to the closing of schools, exacerbated our youth precarious situation. Of particular concern was knowing the vulnerability of Puerto Rican youth to homelessness, including some of our 4-Hers. PRAES is assisting our youth by providing tools to complete high school, prepare and motivate youth to undertake the actions of social justice and economic development. Also, PRAES is fighting against the risk of homelessness among college students by promoting access to fresh food, packaged food, health education experiences, and other services with the support of community-based organizations.

Through interdisciplinary initiatives that integrate 4H members' needs and PRAES program objectives, Extension personnel has assisted our youth through the new program entitled Teens leading the change for community wellness. Some of these initiatives included activities to 1) connected our children and youth with apiculture as an agriculture field that provided scientific knowledge, careers opportunities and entrepreneur alternatives, 2) training to 4H members about healthy living lifestyles and production of food at home and schools, 3) provide spaces to reflect and work about inequities that predispose people to homelessness and 4) educate our 4-H youth in an inclusive place for deaf and blind youth. The most salient achievements of these initiatives are highlighted in the results (4-H: an inclusive space that provides opportunities for children and youth), including:

- Ruta 4-H:
  - 1,294 participants completed non-formal education in healthy lifestyles.
  - 35 youth leaders trained to broaden the educational reach of healthy lifestyles.
  - 5 youth leaders represented Puerto Rico at the Healthy Living Summit 2022.
- ACCESO:
  - Benefited more than 75 homeless people, by receiving articles and food collected in 4-H DropBOX stations.
  - 4-H leader (n=6) provided workshops about general hygiene and hand washing and offered time to organized food storage at homelessness center.
- The Bug Camp:
  - Kids and youth learned about related professional careers in entomology and the role of insects in food production, environmental diversity, and their impact in reducing world hunger.
  - 15 participants completed camp activities and five extension educators served as mentors.
- 4-H Bee Team:
  - 15 4-H participants completed 45 hours of education and practices related to apiculture.

- 5 participants served as peer educators in Pollinators Fairs, in school activities and at the Agri-Innovation Week by Corteva Agriscience.

- Explora
  - 4-H participants (n=56) explored career opportunities and strategies to better face the challenges related to college life

## Merit and Scientific Peer Review Processes

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### Updates

NONE for PRAEXS and PRAES.

## Stakeholder Input

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

NONE for PRAEXS and PRAES.

### Methods to identify individuals and groups and brief explanation

In addition to the methods described in our POW, PRAEXS commodity and program leaders and associated faculty have created Facebook pages to disseminate activities and relevant commodity information. Interested stakeholders making contact through this and other social networks are also invited to attend commodity meetings where needs and priorities are assessed.

### Methods for collecting stakeholder input and brief explanation

Several PRAEXS commodity and program leaders have conducted more formal surveys of stakeholders needs, priorities and concerns, complementing in this manner the information collected through personal communications and evaluation forms distributed at the end of meetings and workshops.

The PRAES Planning and Evaluation Office in conjunction with the Extension Assistant Dean and the Extension Programmatic Leaders updated its survey to collect stakeholder input. The updated survey allows the participants to report their needs considering the Educational Activities integrated into the four Extension Programmatic Areas (i.e., Agriculture and Natural Resources, Positive Youth Development, Community Economy and Sustainable Development, and Family and Well-Being). For example, a Farmer can report a need pertaining to its farm that could be addressed by improving the situation of the community where the farm is located. In addition, the survey now can be sent online or via text message or in paper (the latest particularly helpful for rural areas).

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

Stakeholder input was used to justify a recruitment plan for new faculty with partial research appointments at the PRAEXS, submitted to the Mayaguez Campus Chancellor and UPR's President last year. Needs identified by stakeholders and advanced in this plan included recruiting faculty with expertise in cropping systems and climate change interactions, precision farming, agricultural economics/agribusiness and marketing, and farming under structures or protected agriculture.

In addition, as described in our POW, seven new Hatch projects aligned with priorities identified by stakeholders were initiated last year in areas such as integrated pest management in roots and tubers, formulations for value added fruit products, vegetable production under high tunnels, and low-cost sustainable practices for the production of food crops, among others.

Lastly, an internal assessment of our priority-setting process is currently being conducted by PRAEX research administration in response to stakeholders concerns with the long list of priorities gathered by our current system.

PRAES established a new committee comprising of the Director of the Planning and Evaluation Office, the Extension Planning and Evaluator Specialist, and the Community Economy and Sustainable Development Program Leader. The committee hired a graduated student, specialized in statistics, and using the data collected, descriptive statistics are performed to better address the stakeholder input. The committee will distribute the results along with recommendations to all the Extension Personnel to better address the needs, employing an integration approach among the four Extension Programmatic Areas.

## Highlighted Results by Project or Program

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Critical Issue

### Community, economy & sustainable development

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#### Community self-management, economic development, and volunteers' resilient projects during critical times.

Project Director

Jaime Curbelo

Organization

University of Puerto Rico Mayaguez Campus



## Development of community enterprises to create vibrant communities

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### In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Puerto Rico continues to experience an economic recession for more than a decade. The social and economic vulnerabilities already present in the island are expected to increase soon by the cumulative impact of all the recent phenomena that the Island has experienced. Puerto Rico needs to improve its food security and generate income-producing alternatives that can significantly increase the recovery prospects of its communities.

### Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During this period, we implemented two awards to boost the development of community enterprises to increase food self-sufficiency. The NRCS USDA sponsored an award to educate community organizations about agroecological systems as a resilient management strategy and community enterprise. The project awarded seven community organizations to implement approximately 11 community gardens. The community organizations, with collaboration of Extension personnel, developed organizational plans to build plant stand beds, composting facilities, and irrigation storage reservoirs. They also acquired materials to build the garden sites with the help of their organized volunteers. The project was aimed to start generating income in six months by selling products and services with the use of the new facilities.

The second award was awarded by the NIFA Distant Education Program. The grant provided funding to organize 5 educational centers to train communities about aquaculture systems and marketing. For the project to be sustainable, training about the development of alliances and production and marketing strategies to create the favorable conditions to supply fish to local schools.

As part of our vision, the projects are being developed using the fundamentals of solidarity economy as a guide to reach sustainable development. The projects required that members of the organization raise their capabilities regarding project management (finance, marketing, and accounting) enhancing and building new skills to organize their community enterprises activities through building capacity workshops. Awards provided more than \$75,000 to build the necessary infrastructure. At this moment, the community organization has made a great job restructuring and reorganizing their volunteers time. It has been possible to create greater capacity in new topics, demonstrating the capacity of the participants to be trained in new skills and to organize themselves, improving their community self-management.

### Briefly describe how your target audience benefited from your project's activities.

As part of the educational activities done through the initiatives, achievements reported from follow-up visits include:

- 78 leaders actively participated in the design and development of community projects.
- 23 communities took actions to meet their needs to improve their quality of life through empowerment and community self-management.
- 21 government agencies or other organizations collaborated in the development and organization of the community.
- 204 people collaborated as volunteers.
- 245 hours dedicated through volunteer work as community leaders.
- 2 communities were organized for the preservation and conservation of coastal resources and other natural resources.
- 10 action plans were developed and updated by community members to address a problem.
- 10 coalitions or support networks established in the community.

Particular successes as result of extension contribution through training related to community self-management, economic development, and volunteers' resilient projects include:

#### **Community Development Initiative:**

Mrs. Oquendo, a single woman, businesswoman and owner of an online Jewelry store in Arecibo wanted to expand her store to better provide her family. Through the assistance of extension personnel, she drafted a proposal to incorporate her store into the Morovis Tourism and Culture store. Her proposal was approved and now she sells part of her inventory in the Tourism and Culture store. Oquendo expressed that thanks to the knowledge acquired through Extension, she has managed to improve her business strategy and sales. Her enthusiasm continues to improve her business. The help provided by Extension personnel improved the quality of life of Oquendo and her family because she is now an autonomous mother. She has used her success story and knowledge further to train and support other mothers and women to undertake and seek a livelihood for her families just like her.

#### **Community Garden Initiative:**

The preparation of a community emergency management plan and the organization of volunteer leaders from the municipality of Ponce, led to the preparation of a community census to assess the physical and structural needs of the community. Using this information, the community profile was prepared, and fundraising efforts were organized, which led to the purchase of emergency supplies and equipment for road cleaning. Home gardens (4) and farms (2) in the community increased their diversity and production by adopting practices such as IPM, pruning, and composting. After Hurricane Fiona, the community-owned school canteen was opened, where 5 volunteer leaders prepared breakfast and lunch for the community for three weeks. A total of 2,400 plates of food and 150 non-perishable food purchases were served, impacting more than 100 families in the area. All this in collaboration with Ponce Neighborhood and Hispanic Federation.

#### **Briefly describe how the broader public benefited from your project's activities.**

The program's goal is to provide knowledge and tools that allow our target audience to better address issues related to economic development, self-management, leadership, and volunteering. By improving the economic situation of our participants, we are helping to improve their communities as well, therefore indirectly benefiting other individuals. With the Extension contribution to community organizations helped develop the local food economy and therefore broader public benefited from having fresh and nutritious sourced food nearby.

#### **Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

With the collaboration of field staff, we recently formed three new working groups to promote volunteering, emergency planning and community business incubators.

#### **Consumer attitudes and behavior towards differentiated products in Puerto Rico: An assessment of text, labels and quick response (QR) codes**

Project Director

Hector Tavaréz

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1021265



#### **Annual Results-Consumer attitudes and behavior towards differentiated products in Puerto Rico: An assessment of text, labels and quick response (QR) codes**

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#### **In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

This project seeks to use data from questionnaires to evaluate consumer attitudes and behavior towards text, logos and quick response codes in packages of differentiated coffee and in containers of differentiated milk. The study also seeks to use a variety of strategies to disseminate research results to stakeholders at multiple levels.

#### **Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

We worked on the overall design of product packages, logos and videos necessary for the survey design. We distributed surveys through in-person interviews at multiple municipalities. Coffee and milk data were successfully collected by 3 interviewers who received training on data collection.

#### **Briefly describe how your target audience benefited from your project's activities.**

We have been publishing the results using a variety of dissemination strategies. Stakeholders and farmers can benefit from this study in the future if agricultural policies are legislated as a result of this study.

**Briefly describe how the broader public benefited from your project's activities.**

Students, professors, and farmers are aware of the results of this study. Future studies can extend this research to other agricultural crops. Farmers can use the results of this study to commercialize differentiated products. In fact, the results of this study could be applied to other sectors of the economy, beyond agriculture.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training and professional development opportunities** - We organized two seminars oriented to students. The first seminar focused on survey design and distribution. The second seminar was oriented to data entry and data analysis.

**Dissemination of results**-Although we presented study results in different locations, these efforts were completed after September 30, 2022.

**Plans for next reporting period** - This project ends in September 2023. We presented study results at SOPCA and we plan to present study results in the annual meeting of the coffee and milk sectors organized yearly by the College of Agricultural Sciences of the University of Puerto Rico. We also plan to present study results in the 60th annual meeting of the Caribbean Food Crops Society, which will be held in Grenada in July 2023.

**Publications:**

Tavárez, H., Cortés, M., & Hernández, J. (Submitted). Consumer attitudes and behavior towards differentiated products in Puerto Rico: An assessment of text, logos and quick response (QR) codes. *Economía Agraria y Recursos Naturales*.

Tavárez, H., Cortés, M., & Gregory, A. (pending). Preferencias de los consumidores por leche producida asegurando el bienestar animal en Puerto Rico. *Journal of Agriculture of the University of Puerto Rico*

**Other Products:**

**Activities:** We collected data from survey distribution. The data was analyzed accordingly.

**Events:** Students received training on data analysis using the dataset generated from this study.

**Product:** We are using resources from other project to construct a website to store databases from multiple projects. We are working on the dataset of this study. Data generated from this study will be freely available to anyone interested in this study.

Critical Issue

## Extreme weather, environment, natural resources, and sustainable energy

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### Natural resource protection amid extreme weather and natural disasters

Project Director

Jaime Curbelo

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

7002484



**Mitigating the impact of climate change on agricultural production by improving agricultural practices, supporting soil and water conservation, and encouraging composting.**

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**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Extreme weather events such as hurricanes, very intense rainstorms, and flooding, which have now become more common, are main contributors to soil erosion with its negative consequences on watersheds. As the world continues to experience the effects of climate change, no group will be impacted more than farmers, and each growing season seems to come with more challenges than the previous. Prime agricultural land is a limited resource on the island and is constantly threatened by urbanization and soil erosion. Though Puerto Rico's agriculture is very diverse, characterized mainly by small family production units, the effects of land degradation without mitigation strategies will become insurmountable in the near future.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

The activities and educational efforts during 2022 associated with the critical issue Extreme Weather, Environment & Sustainable Energy were focused on mitigating the impact of climate change on agricultural production by improving agricultural practices, supporting soil and water conservation, and encouraging composting. Instruction and service to farmers and other stakeholders across the island were made through



various in-person and virtual trainings.

Six workshops covering soil sampling, soil analysis interpretation, and nutrient recommendations were provided for the agricultural agents that cover municipalities across the island. In addition, 15 trainings on soil management and fertility were offered with 75 farmers attending. Soils from 30 farms were sampled, analyzed and the results were discussed with farmers providing the appropriate recommendations. Collaborations between PRAES and NRCS resulted in the dissemination of soil nutrient management information to farmers, producers and the general public.

Educational efforts on soil erosion control have continued to increase awareness of soil resource conservation and agricultural resilience due to climate change. These included training workshops on watershed protection, water harvesting, and storage that have been offered at extension offices and in the field. Eighteen individuals were trained in the protection of water quality and conservation of watersheds near agricultural farms, 36 individuals were trained in soil erosion control and soil health, and 24 individuals were trained in rainwater collection, storage and reuse in the farm.

Climate change is one of the most significant challenges that Puerto Rico is facing today. Workshops focused on improving agricultural resiliency and the protection and conservation of natural resources were provided using the established PRAES curriculum guide "Climate Change: Impact on agricultural production and methods of adaptation" with a total of 93 individuals in attendance.

### **Briefly describe how your target audience benefited from your project's activities.**

#### **Soil management and conservation**

Soil conservation and nutrient management training resulted in the adoption of practices and recommendations that have improved the conditions on more than 45 farms. Eleven farmers incorporated the use of soil amendments based on soil fertility results. Eight farmers changed their fertilizer formulations to more closely coincide with the needs of the crops grown. Fifty-two individuals adopted recommended conservation practices to effectively manage the soils on their farms.

One success story involved a new eggplant farmer in Isabela. The farm was previously dedicated to forage for cattle and was not in the best conditions. After several visits, trainings, and recommendations from the local agricultural agent the farmer was able to reduce his fertilizer application by 75% while maintaining vegetable production. Through the various visits he also learned about the importance of plant nutrition, how to read soil test results, how to recognize beneficial insects and practices to control for plant pests. He is currently in the process of starting a second farm.

#### **Agricultural resilience and natural resource protection due to climate change**

More than 15 individuals/farmers adopted practices that will improve agricultural resilience and natural resource protection in the face of climate change. Four farms implemented or improved water collection systems on their properties while three farms prepared contingency plans and obtained agricultural insurance in case of natural disasters. Three adult volunteers collaborated in activities to prepare for extreme weather events.

Two natural resources conservation initiatives worth mentioning occurred in Ponce, Puerto Rico. The first focused on urban forestry and green area conservation. Ninety-nine youth from the city of Ponce participated in planting 137 trees at an important local recreational park (Luis A. Wito Morales Crespo park). A manual on the management of forest resources in peri-urban zones was developed as one of the project objectives and will be used for future trainings. The second project involved the cleaning of coastal areas. Ninety-five youth, 4 adult volunteers, and 3 forest rangers collected trash, filling over 100 bags, from the Punta Cucharas Natural Reserve. The youth learned about the natural resources of the area, proper waste management, and the benefits of working as a team.

#### **Composting**

The training on composting at home for the communities in Fajardo resulted in four families now composting materials from their kitchens to provide nutrients to their home gardens. One farmer also adopted composting practices on their farm in the reuse of crop residues.

### **Briefly describe how the broader public benefited from your project's activities.**

The project's goal is to mitigate the effects of climate change on agricultural production by increasing the use of sustainable agricultural practices that protects Puerto Rico's natural resources. The broader public benefit directly from a more sustainable local food source and indirectly from the protection of natural resources that provide raw materials, fuel, recreation, and aesthetics to the island.

#### **Microirrigation: A Sustainable Technology for Crop Intensification and Improved Crop Productivity**

Project Director

Elvin Roman-Paoli

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1021263



**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Water scarcity or the lack of rainfall uniformity in some regions of Puerto Rico is a problem that requires special attention to maintain or increase yields without jeopardizing the environment. The response of coffee and avocado to drip irrigation and fertilization management on contrasting environments is being evaluated to address that problem. Also, in this project techniques such as remote sensing were used to increase knowledge in Puerto Rico and the Caribbean region on climate change, issues with reservoirs that supply irrigation districts, issues with aquifers, drought monitoring.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Puerto Rico in recent years has been affected by hurricanes that have continued to reduce agricultural production in the island. This project is addressing economically important crops, such as coffee, and fruit trees, such as avocado, that were affected by those atmospheric disturbances. For avocado, farmers mainly use drip irrigation systems, however there are many aspects that could be improved in terms of a more efficient use of water and the application of fertilizers through the system. Another crop greatly affected was coffee. Coffee production is mainly established in the mountainous region of PR, where there is generally high rainfall, but not evenly distributed. Farmers have the false notion that a drip irrigation system on their farms is not necessary. With our project we try to prove the hypothesis that the installation of a drip irrigation system in coffee plantations has benefits for the production, and a better management of fertilizers through the system.

**Briefly describe how your target audience benefited from your project's activities.**

Farmers, agricultural professionals, and students have been informed about the research results. They have been provided with the skills needed to improve the adoption of these practices on their farms.

**Briefly describe how the broader public benefited from your project's activities.**

The society must understand that their agricultural sector must be protected and improved so that dependence on food imports from other jurisdictions is reduced.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training and professional development opportunities** - With the implementation of this project, leaders, coleaders, research assistants and graduate and undergraduate students have been given the opportunity to improve their knowledge by attending conferences and obtaining training both in the classroom and in the field.

**Dissemination of results (outreach activities)** - Results have been disseminated through peer reviewed publications, oral and written presentations, field days and formal and informal teaching.

**Plans for next reporting period** - We are planning to continue with field research, and prepare oral and poster presentations. A graduate student was hired to work in the avocado project at Lajas and Isabela substation. Three manuscripts are being written regarding research findings in the project, and we are planning to publish them on the incoming year.

**Major changes or problems** - Despite the fact that in the last 5 years Puerto Rico were affected by three hurricanes, earthquakes and a covid pandemic, work has continued on the project. Some delays and damages to the experiments established in the field were overcome.

#### **Publications:**

Peer reviewed publications

Harmsen, E.W.; Mecikalski, J.R.; Reventos, V.J.; Alvarez Perez, E.; Uwakweh, S.S.; Adorno Garcia, C. Water and Energy Balance Model GOES-PRWEB: Development and Validation. *Hydrology* **2021**, *8*, 113. <https://doi.org/10.3390/hydrology8030113>

Piasecki, M.; Harmsen, E. Hydrology in the Caribbean Basin. *Hydrology* **2022**, *9*, 22. <https://doi.org/10.3390/hydrology9020022>.

Román-Paoli, E., J. Ortiz-López, J. Zamora-Echevarría, and F. Román-Pérez. 2021 Fertilization Methods Affecting 'Tahiti' Lime (*Citrus latifolia*) Fruit Yield and Profitability. *J. of Agric. of the Univ. of Puerto Rico*. 105(2): 163-177.

Tirado-Corbalá, R., E. Román Paoli, J. Muñoz. 2021. Fertilization and precise irrigation scheduling for mature avocado. *J. of Agric. of the Univ. of Puerto Rico*. 105(1):73-88.

Tirado-Corbalá, R., E. Román-Paoli A. Segarra-Carmona C. Estévez de Jensen, D. Rivera-Ocasio. 2022. Early response of Mexican lime, Fina clementine mandarin and Campbell valencia orange on selected rootstocks grown under fertigation practices in an Oxisol in Puerto Rico. 8(6), 513 <https://doi.org/10.3390/horticulturae8060513>.

Personal presentations

Román Paoli, E. Evaluación del uso de riego por goteo en la productividad de café (var. Catuaí). Annual Scientific Meeting. Puerto Rican Society of Agricultural Sciences. December 2, 2022, Coamo, PR. Poster presentation.

Irrigation Research Conducted by UPR-AES in Dragon Fruit. August 15, 2022. Homestead Research and Development Center. FL. Oral presentation.

Drip irrigation management according to FSM Act. April 31 2022. Lajas Substation, Agricultural Experiment Station, University of Puerto Rico. oral presentation.

## **Forestry Innovation Laboratory and Learning Institute (FILLI): Using Hurricane Maria's lessons and opportunities to support long-term sustainable**

Project Director

Mario Flores-Mangual

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1016450



### **Annual Results-Forestry Innovation Laboratory and Learning Institute (FILLI): Using Hurricane Maria's lessons and opportunities to support long-term sustainable**

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#### **In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Hurricanes affect trees and produce a surplus of vegetative material that can potentially be used (e.g. to produce biochar for growing media and soil amendments). These materials can be used for tree growth in reforestation efforts. In addition, there is the need to restore forests that have been impacted by hurricanes in Puerto Rico.

#### **Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

1. **The use of vegetative waste to produce biochar and woodchips, and to test these as soil and growing media amendments.** We tested the biochar and woodchips as part of growing media to grow *Tabebuia heterophylla* trees in pots. We also started growing a field experiment applying biochar and chicken manure as soil amendment to grow trees.
2. **Outreach on forest product management and uses** - We did two presentations of some of the results of the project as part of the meeting (date: May 6, 2022) named: Manejo de bosques en sistemas social-economicos de Puerto Rico. The titles of the presentation were: 1) Uso de biochar de arboles no-nativos en medios de cultivo (The use of biochar produced from non-natives trees as part of growing media), and 2) Hacia un Laboratorio de Manejo de Bosques y Productos Forestales en el RUM (Towards a Forest Management and Products Laboratory at UPR-Mayaguez).

#### **Briefly describe how your target audience benefited from your project's activities.**

As part of Conference on May 6, 2022 we presented to farmers, forest managers, extensionists, and the general public the benefits of using forests products that locally may be considered waste. Part of the audience have reached out to us as they are interested in applying some of our results. For example, there is a group that is starting to produce biochar from waste vegetative materials that accumulate in rivers. They are highly interested in collaborating with the University to do research on the use of this biochar for plant growth.

#### **Briefly describe how the broader public benefited from your project's activities.**

We are currently working hand to hand with Para La Naturaleza, a NGO dedicated to the conservation and reforestation of protected ecosystems. The results on how to use biochar will directly help on possible new formulations of growing media that include less amount of Promix. In addition the data generated on the test of biochar in the field will help them improve their reforestation strategies. For example, we are testing biochar as soil amendment, in Corozal Experiment Substation, in highly degraded soils that are limiting the reforestation of protected areas. All this information not only benefits Para La Naturaleza, but also all groups, Government Agencies and land owners interested in reforestation and forest products. In addition, we created videos that are available to the general public in internet platforms such as YouTube. In May 2022 we are presenting at a forest conference of UPRM the first experiments testing the biochar as part of growing medium, and this year we will be presenting the results of field experiments.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training and professional development opportunities** - We have trained several farm workers (at least four) in the use of the sawmill. This has been done inviting local sawmill owners, that kindly have provided their time and expertise to participate in these trainings. From these trainings we have generated videos that we hope will teach the general public about the use of sawmills. We also trained one technician and one graduate student on the preparation of biochar. Also, the technician was trained in plant growth and tree nursery management.

**Dissemination of results**- We posted videos in the SEA-UPRM webpage of an outreach activity where local sawmill owners did trainings on sawmill maintenance and uses. In this activity we invited local landowners, arborists, Natural Resources agents and USDA Forest Services personnel. From these trainings we have generated 3 videos that we hope will teach the general public on the use of sawmills. We also did another video the same day explaining the benefits of biochar. All four videos are done with editing and will be posted on YouTube for the benefit of the general public.

Also, we presented some of the results in a conference on May 6, 2022 that was organized by Agricultural Experiment Station-UPRM named: Manejo de bosques en sistemas social-economicos de Puerto Rico. This conference was online and was open to everyone.

**Plans for next reporting period** - We are currently performing a field experiment in the Corozal AES testing the biochar as soil amendment for the growth of native trees. We are including chicken manure as part of the treatments to compare the biochar to a common soil amendment. We will monitor plants after the closing date of the project (September 30, 2023) but we will include the preliminary results in the final report.

**Major changes or problems** - The biggest problem the research has had was the initial lockdown of Covid-19 that caused the research to be behind schedule. Last period we had hurricane Fiona that limited the work at the end of the reporting period. We also lost the data of a second experiment on the use of biochar to grow trees in growing media due to an error on the collection of the growing media samples. We will try to run again this second experiment, but we may not have enough time before the project funding ends. However, I believe that we have enough information from the first experiment to be able to publish the information.

#### **Publications:**

Flores-Mangual, M.L., M.A. Pagán-Lopéz and E.A. Román Aponte. (To be submitted). Use of biochar from non-native trees as part of growing media for basil growth. To be submitted, in an internal review process, to: Journal of Agricultures of the UPR.

Abelleira Martínez, O.J., G. Túa Ayala y Rey E. Cruz Aguilar. 2021. Intervenciones de Forestería Análoga en Bosques Secundarios Puertorriqueños. Presentación oral *en-línea* en el XI Simposio Internacional sobre Manejo Sostenible de los Recursos Forestales (SIMFOR) el 26 de noviembre de 2021 en la Universidad de Pinar del Río, Cuba (vía Zoom).

Abelleira Martínez, O.J., J. Rivera San Antonio, G. Túa Ayala, R. Cruz Aguilar, G. Báez Rivera, A. Marengo Casul, M. del R. Suárez, y A. Pérez Méndez. 2022. Hacia un Laboratorio de Manejo de Bosques y Productos Forestales en el RUM. Presentación oral *en-línea* en el foro Manejo de Bosques en Sistemas Social-Ecológicos de Puerto Rico del Área Programa?tica de Climas Extremos, Recursos Naturales y Energi?a Renovable de la Estación Experimental Agrícola de la UPR llevado a cabo el 6 de mayo de 2022 vía Zoom.

#### **Other Products:**

1. Equipment: The project allowed for the purchase of a Thermo Scientific Heratherm oven and a Norwood sawmill for the FILLI's facilities in Finca Alzamora and a Wood-Mizer sawmill at the Corozal Experiment Substation. Both sawmills have been used for outreach activities related to the use of forest products. The Alzamora sawmill has been also used as part of the research objective that explores the used of softwoods from invasive species.
2. Databases: We built a page in Facebook that includes information about the ongoing progress of the research, outreach information, announcements and other information related to forest management and forest products in Puerto Rico.
3. Videos: We produced four videos that were edited and posted last year at the UPRM website. The videos included trainings on the use of a sawmill. And also we did a video on the benefits of producing biochar. The link to the videos are:
4. Forest Innovation: <https://www.youtube.com/watch?v=v7joFvfV0IY&list=UULFA8CUw5QzG-LmmttmFiCB6g&index=14>
5. Conceptos Básicos del Mantenimiento de un Aserradero Parte 1/3: <https://www.youtube.com/watch?v=8uy4KSDa59s&list=UULFA8CUw5QzG-LmmttmFiCB6g&index=13>
6. Herramientas Básicas y Equipos de Protección Parte 2/3: [https://www.youtube.com/watch?v=OeBgf4sN\\_XI&list=UULFA8CUw5QzG-LmmttmFiCB6g&index=12](https://www.youtube.com/watch?v=OeBgf4sN_XI&list=UULFA8CUw5QzG-LmmttmFiCB6g&index=12)
7. Corte de Troza de Madera en Aserradero Parte 3/3: <https://www.youtube.com/watch?v=cbI6hIO7QO8&list=UULFA8CUw5QzG-LmmttmFiCB6g&index=11>



**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Soil salinity and sodicity (saline soils) is a major factor limiting crop productivity worldwide. The areal extent of saline soils in Puerto Rico may be near 2%. The soils are important as most areas have irrigation-drainage infrastructure, and the soils can be quite productive if managed adequately. One important agricultural area is the Lajas Valley Agricultural Reserve which encompasses an area of over 40,000 acres primarily of Vertisols with irrigation-drainage infrastructure. The spatial distribution and extent of soil salinity was evaluated in the 1950s. There is a need to evaluate changes in the magnitude and spatial extent of soil salinity.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Soil samples from 0 to 120 cm depth, were gathered from the Lajas Valley watershed. The major soils of the area are Typic Haplusterts, Sodic Haplusterts, and Typic Calciaquerts. Soil electrical conductivity (EC) and sodium adsorption ratio (SAR) were quantified in saturated paste extracts (ECe and SARE) and in 1:5 (soil:solution) extracts (EC1:5 and SAR1:5). Significant empirical quantitative relationships were established between EC1:5 and ECe and SAR1:5 and SARE. Soil EC and SAR measurements in 1:5 extractions allow for a quick and efficient method to estimate ECe and SARE, respectively.

Soil apparent electrical conductivity (ECa) was determined using electromagnetic induction with EM-38® (Geonics Limited, Ontario, Canada) in selected polygons encompassing an area of 1,289 ha of the Lajas Valley. GIS-based regressions between ECaV (vertical mode) and ECe, allowed for estimation of ECe and extrapolation of ECe to the area mapped with EM-38. GIS-based maps of saline, sodic and saline-sodic, based on USSS (1954) categorizations, were developed. Categorizations of saline and sodic soils mapped using our technique differed substantially from soil taxonomic classifications in USDA-NRCS (2008) [1].

A regional-based soil salinity-sodicity predictive model was tested using simple, multiple, and artificial neural network (ANN) analysis. A geodatabase was created using multiple layers (polygons and rasters) which included dependent, regression, and extrapolated variables. These included (i) ECe, SARE quantified in this study and ECe and SARE quantified by Bonnet and Brennes (1958) (ii) 1993 aerial photograph, Landsat 8, Sentinel 2A (images from 2015-2020) spectral bands, NDVI, LIDAR; (iii) soil taxonomic classes, elevation, slope, geology, surface curvature, surface water flow, soil cover, subsurface water flow. A raster database with 10m resolution was created. Simple and multiple regression models were run to predict current state soil ECe and SARE. The ANN model was assembled using Python® and Google® Colab. The entrance layer included regression and extrapolated variables. The model was trained to a maximum of 100 iterations until convergence to obtain highest regression coefficient and root-mean square error. The three models predicted current state soil ECe and SARE in 7,723 ha. The ANN showed improved soil salinity and sodicity prediction than traditional simple and multiple regression analysis. The spatial variability of soil salinity (ECe) and sodicity (SARE) to a depth of 0 to 60 and 0 to 120 cm, was described in a spatial GIS-based model for 1958 and 2020 conditions. The current state status was that normal, saline, sodic, and saline-sodic soils occupied 69, 27, 0, and 4.3% of the area surveyed. A comparison of the current state area of each soil class to that in 1958 showed that 42% of the soils were normal and did not change, 7% of the soils that were saline changed to normal, 3% of the soils changed from sodic to normal, 10% of the soils that were normal became saline, and 16% of the saline-sodic soils changed to normal. There was a net increase of 18% of the soil area previously affected by excess salts and sodium to normal status.

Twelve soil patterns distributed in 751 ha located in different positions of the landscape were identified: (i) normal tumors, (ii) pond tumors, (iii) melon hole tumors, (iv) stony tumors, (v) soils with vertical cracking, (vi) depressions, (vii) hay affected by salts, (viii) wetlands, (ix) springs, (x) surface salts, (xi) outcrops plants, (xii) and an anthropic sulfur deposit.

[1] USDA-NRCS. 2008. Soil Survey of San German Area. USDA-NRCS.

**Briefly describe how your target audience benefited from your project's activities.**

Saturated paste EC and SAR (ECe and SARE) can be effectively predicted using 1:5 soil:water extractions. This reduces the cost and time of analysis. A protocol for measuring ECa using electromagnetic induction was developed, which permitted assaying large land areas by reducing time and efforts. ECa using EMI can be used to predict ECe and SARE using GIS-based tools. The spatial extent and magnitude of soil salinity and sodicity at a regional scale can be done using ANN analysis. The results can be used to describe the current state soil salinity and sodicity at a spatial scale. Changes in soil salinity and sodicity relative to that in 1958 can be determined.

**Briefly describe how the broader public benefited from your project's activities.**



The use of EMI can be used at a field-scale to assess ECa and with the tools generated can be used to predict ECe and SARe. Field-scale ECe and SARe can be used to identify areas that need reclamation. The procedures developed to calculate regional scale ECe and SARe are robust and scientifically objective and can be used by other researchers elsewhere to identify saline and sodic soils.

We are not aware of the use and application of ANN to predict saline and sodic soils at regional scales so that the procedures used constitute a novel approach to an old problem that will improve saline and sodic soils identification in Puerto Rico and elsewhere. Quantitative equations can be used to convert EC and SAR (based on the solution concentration of Ca, Mg and K) in saturated paste from that measured in 1:5 solution extract. Soil salinity changes from 1958 to present show that there was an overall improvement in 18% of the studied area of approximately 7,723 ha.

The current state soil salinity and sodicity at a spatial scale of the Lajas Valley can be assessed using existing software or mobile application. The empirically based sampling points have accompanying soil fertility, chemistry data that can be used to further understand the soil conditions in specific geographic locations. The data can be used to further understand the factors causing salinization and sodification of soils.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training & professional development:** Graduate students and undergraduate students were trained in project planning, hypothesis development, laboratory procedures, data reduction and interpretation, and scientific writing, the use of EMP-400 and EM-38 instrumentation. Two students graduated from MSc program. Graduate students and undergraduate students were trained in data representation using GIS tools and data analysis and interpretation. Collaboration between USDA-NRCS-Puerto Rico State and Field Office soils staff, University of Mayaguez, Puerto Rico, NRCS-National Soil Survey Center and USDA-ARS, was done to conduct preliminary salinity surveys using the Profiler EMP-400 sensor manufactured by Geophysical Survey Systems, Inc. (Salem, NH), from 7 to 12 May 2018. Collaboration between USDA-NRCS Mid-Atlantic and Caribbean Area Soil Survey Region (SSR 3) and with scientists, graduate students, and undergraduate students from UPRM College of Agricultural Scientists. The assembled team identified, accessed and collected soil samples from pre-selected geographic sampling points, during a five-day period of July and August 2020. The profiles were described in details and horizons were sampled in the laboratory.

**Publications:**

1. Sotomayor-Ramírez, D., J.P. Castro Chacón, B. Alvarez-Torres, L. Pérez-Alegría, G. Martínez-Rodríguez, T. DeSutter. 2021. Catastro de suelos salinos y sódicos en el Valle de Lajas, suroeste de Puerto Rico. Foro en Conmemoración del Día Mundial de Suelos. Virtual. 3 diciembre 2021. República Dominicana. Ministro de MedioAmbiente y Recursos Naturales, Sociedad Dominicana de la Ciencia del Suelo, Food Agriculture Organization.
2. Sotomayor-Ramírez, D., J.P. Castro Chacón, B. Alvarez-Torres, L. Pérez-Alegría, G. Martínez-Rodríguez, T. DeSutter. 2021. Los suelos salinos y sódicos en el Valle de Lajas, suroeste de Puerto Rico. ArteSueloSer. Conferencias Educativas. Reserva Natural Las Cabezas de San Juan, Fajardo.
3. J.P. Castro Chacón, D. Sotomayor-Ramírez, B. Alvarez-Torres, L. Pérez-Alegría, G. Martínez-Rodríguez, T. DeSutter. 2021. Gomorphology and soil salinity of Lajas Valley, Southwestern Puerto Rico. Texas A&M AgriLife. Soil Survey and Land Resource Workshop. Virtual. Texas. 4-5 February 2021.
4. Sotomayor-Ramírez, D. 2020. An updated Assessment of Soil Salinity of the Lajas Valley Agricultural Reserve. Caribbean Area Soil Survey Work Planning Conference MS TEAMS Meeting - September 16, 2020 National Cooperative Soil Survey (NCSS)
5. Castro Chacón, J.P., D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, B. Álvarez-Torres, T. DeSutter. 2020. Geomorphology of the Lajas Valley, Puerto Rico. 2020 ASA-CSSA-SSSA International Annual Meeting. Nov. 9-13. Virtual Mode.
6. Castro Chacón, J.P., D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, B. Álvarez-Torres, T. DeSutter. 2020. Extrapolation models of apparent electrical conductivity (ECa) in the Lajas Valley, Puerto Rico: From the local to the regional scale. 2020 ASA-CSSA-SSSA International Annual Meeting. Nov. 9-13. Virtual Mode.
7. Álvarez-Torres, B., J.P. Castro Chacón, D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, T. DeSutter. 2020. Field-scale assessment of soil salinity and sodicity in the Lajas Valley, Puerto Rico. 2020 ASA-CSSA-SSSA International Annual Meeting. Virtual Mode. Nov. 9-13. Virtual Mode.

8. Álvarez-Torres, B., J.P. Castro Chacón, D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, T. DeSutter. 2020. Alternative methods for the evaluation of soil salinity in the Lajas Valley, Puerto Rico. 2020 ASA-CSSA-SSSA International Annual Meeting. Nov. 9-13. Virtual Mode.
9. Castro Chacón, J.P., D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, B. Álvarez-Torres, T. DeSutter. 2020. Spatial Artificial Intelligence: Exploring machine learning for soil salinity mapping in the Lajas Valley. Symposium COHEMIS - PRSYIG. Mayaguez, Puerto Rico. 30 Oct. 2020.
10. Castro Chacón, J.P., D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, B. Álvarez-Torres, T. DeSutter. 2019. Cartografía regional de suelos salinos y sódicos en la Reserva Agrícola del Valle de Lajas. Primer Congreso de Geografía Eugenio María de Hostos. 1 Nov 2019. Biblioteca Nacional, San Juan, Puerto Rico.
11. Álvarez-Torres, B., J.P. Castro Chacón, D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, T. DeSutter. 2019. Análisis geo-edafológico de suelos salinos y sódicos utilizando inducción electromagnética en la Reserva Agrícola del Valle de Lajas, Suroeste de Puerto Rico. Primer Congreso de Geografía Eugenio María de Hostos. 1 Nov 2019. Biblioteca Nacional, San Juan, Puerto Rico.
12. Álvarez-Torres, B., J.P. Castro Chacón, D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, T. DeSutter. 2019. Análisis geo-edafológico de suelos salinos y sódicos utilizando inducción electromagnética en la Reserva Agrícola del Valle de Lajas, Suroeste de Puerto Rico. Primer Congreso de Geografía Eugenio María de Hostos. 1 Nov 2019. Biblioteca Nacional, San Juan, Puerto Rico.
13. Castro Chacón, J.P., D. Sotomayor-Ramírez, L. Pérez-Alegría, G. Martínez, B. Álvarez-Torres, T. DeSutter. 2019. Initial steps towards assessing soil salinity at regional scale in Lajas Valley. 25 Apr. 2019. Annual Conference SIGMA XI. Mayaguez, Puerto Rico.
14. D. Sotomayor-Ramírez, J.P. Castro Chacón, L. Pérez-Alegría, G. Martínez, B. Álvarez-Torres, T. DeSutter. 2019. Inducción Electromagnética para la evaluación de la salinidad del suelo en el Valle de Lajas, suroeste de Puerto Rico. XXII Congreso Latinoamericano de la Ciencia del Suelo. Montevideo, Uruguay. 7 al 11 octubre 2019.
15. Sotomayor-Ramírez, D. L. Pérez-Alegría, G. Martínez, B. Alvarez, J.P. Castro-Chacón. 2018. An updated assessment of soil salinity of the Lajas Valley Agricultural Reserve, Puerto Rico. USDA-NRCS Soil Survey Planning Conference. 1-Nov-2019. Mayagüez, Puerto Rico.
16. Alvarez, B., D. Sotomayor-Ramírez. 2018. A preliminary approach towards mapping soil salinity in the Lajas Valley, Puerto Rico using electromagnetic induction. Puerto Rico Agricultural Biotechnology Association (PRABIA) 2018 Meeting. 23-Aug-2019. San Juan, Puerto Rico.
17. Alvarez, B., D. Sotomayor-Ramírez, M. Matos, L. Pérez-Alegría, S. Ríos, W. Tuttle. A preliminary approach towards mapping soil salinity in the Lajas Valley, Puerto Rico using electromagnetic induction. Soil Science Society of America International Soil Meeting 2019 (SSSA). 7-Jan-2019. San Diego, CA, USA.
18. Alvarez, B., D. Sotomayor-Ramírez, M. Matos, L. Pérez-Alegría, S. Ríos, W. Tuttle. A preliminary approach towards mapping soil salinity in the Lajas Valley, Puerto Rico using electromagnetic induction. Farm Foundation Round Table. 17-Jan-2019. San Mateo, CA, USA.

**Other Products-** Two graduate students participated in the project. Two MSc thesis were developed.

*Alvarez, B. 2021. Magnitud y distribución espacial de la salinidad y sodicidad del suelo a escala de campo Enel Valle de Lajas, Puerto Rico. MSc Thesis. University of Puerto Rico, Mayagüez Campus. Department of Agro-environmental Sciences. 105 p.*

*Castro Chacón. 2021. Cartografía regional de suelos salinos y sódicos en el Valle de Lajas, suroeste de Puerto Rico. MSc Thesis. University of Puerto Rico, Mayagüez Campus. Department of Agro-environmental Sciences. 169 p.*

Five undergraduate students worked directly under the direction of graduate students B. Alvarez and J.P. Castro. The students were trained in soil sampling, electromagnetic induction instrument operation, ECa spatial analysis, laboratory analysis, data management.

★ **Final Report- Development of a drone-based sensor approach for monitoring the occurrence and spatial distribution of algae blooms in reservoirs of Puerto Rico**

Final Result

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

The emergence of hazardous algae blooms has been termed the single most pressing freshwater quality threat of future generations. The detection of blooms through conventional field-monitoring excursions is particularly ineffective due to the fleeting, and spatially heterogeneous nature of algal blooms. Satellite-based sensor technologies are rapidly evolving as efficient forecasting and diagnostic tools to identify/monitor the temporal and spatial distribution of potentially hazardous blooms. Challenges with spatial resolution, low image frequency, and cloud cover impact severely limit the application of satellite imaging to small reservoirs. Alternatively, we proposed the development of a drone-based sensor technology to monitor the incidence of algae blooms in reservoirs of Puerto Rico.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Phytoplankton response studies: Numerous field bioassays were conducted to evaluate the relative effects of different suspected of phytoplankton productivity. Treatments considered were nutrients (nitrogen (both as (NO<sub>3</sub>- or NH<sub>4</sub>+)), phosphorus, calcium, magnesium iron, boron, zinc, manganese and organic carbon. Different concentrations of each element (source) were considered, individually as well as in combination with other factors. Studies were conducted at Cerrillos, an oligo-mesotrophic reservoir on the South region of Puerto Rico.

Nutrients (i.e., N, and P) were the most influential drivers of phytoplankton productivity. Phytoplankton responded similarly to both nitrogen and phosphorus, which acted synergistically when combined. There was no significant difference in phytoplankton response to nitrogen source (i.e., NO<sub>3</sub>- or NH<sub>4</sub>+). Biomass productivity followed a logarithmic response with saturation values reached at elevated nutrient concentrations. Chlorophyll a increases increased trophic levels from the usually oligo-mesotrophic condition of this reservoir to eutrophic levels. Results reaffirm recent findings (which contradict longstanding beliefs) that both nitrogen and phosphorus are important drivers of phytoplankton productivity in tropical reservoirs, with nitrogen being more influential in most cases. This requires protective measures for preventing enrichment on both nutrients.

Bathymetry study: A bathymetry study of La Plata reservoir was completed. After hurricane Maria (Sept., 2017) government agencies were in need of determining the storage capacity of the island reservoirs as part of the recuperation efforts. La Plata is one of two of the most important reservoirs in the island providing water for a significant portion of the population of the San Juan metropolitan area. Results revealed that the reservoir had a storage capacity of 30.88 Mm<sup>3</sup> adjusted to its maximum elevation of 52 m ASL. This value (i.e., 30.88 Mm<sup>3</sup>) is similar to the storage capacity reported on 2015. Considering that approximately 260,000 m<sup>3</sup> of sediments were removed right after the 2015 bathymetry study as part of a dredging effort, we must conclude that a similar amount was deposited as result of hurricane Maria. The fact that the reservoir floodgates were kept open during the hurricane seemed to have prevented greater sediment accumulation. A chlorophyll a map for Cerrillos reservoir based on Sentinel satellite images was produced. Continuous (1hr-interval) temperature and light depth profiles for Cerrillos reservoir (0.5m, 1m, 2m, 3m and 4m) were produced.

**Briefly describe how your target audience benefited from your project's activities.**

The target audience for this project was the Puerto Rico Department of Natural Resources and Environment personnel. Temperature data from our self-standing buoy (sensors at 0.5m, 1m, 2m, 3m and 4m) was used by the Department of Natural Resources personnel to evaluate the potential effect of changing temperatures on increasing mortalities of adult largemouth bass at Cerrillos.

Also, despite the series of catastrophic events that occurred in Puerto Rico since the project's onset we were able to characterize the limnological status of La Plata and Cerrillos reservoirs. La Plata is a mesotrophic-eutrophic reservoir with highly anoxic conditions at the hypolimnion, whereas Cerrillos is an Oligotrophicmesotrophic reservoir whose hypolimnion only experiences anoxia during a very short time span during the year. Secchi disk transparency is approximately 1m deeper (e.g., 2.5m vs 1.5m) at Cerrillos than at La Plata. Field trials were conducted to evaluate the spatio-temporal (tri-dimensional) variability in primary productivity (Chl-a) in both reservoirs. Both reservoirs exhibit a Chlorophyll a maximum at depths greater than 1m which constitutes a challenge for accurately describing primary productivity through aerial images.

In addition, numerous field bioassays were conducted to evaluate the effects of nutrients, and inorganic constituents on phytoplankton productivity. Treatments considered were nutrients (nitrogen (both as (NO<sub>3</sub>- or NH<sub>4</sub>+)), phosphorus, calcium, magnesium iron, boron, zinc, manganese and organic carbon. Among all factors and treatment combinations considered nutrients (both N and P) were the most influential drivers of biomass production. There was no significant difference between nitrogen source (i.e., NO<sub>3</sub>- vs NH<sub>4</sub>+). The combination of N and P resulted in higher productivity than that of each element by itself. Most other elements were relatively innocuous to biomass production, except for boron which hindered productivity.

**Briefly describe how the broader public benefited from your project's activities.**

Real or near-real time detection of harmful algae blooms HABs is critical to establishing adequate notification guidelines for specific target audiences (nearby residents, recreational users, drinking water plant managers, etc.), and implementing effective management and protective efforts of the resources.

Another major accomplishment of the project was the completion of a bathymetry study at La Plata reservoir. Although not an initial objective of this project, the need for a bathymetry study was deemed critical after hurricane Maria as government agencies were trying to establish the hurricane's impact on water storage capacity. La Plata is one of two of the most important reservoirs of Puerto Rico as it provides water for a significant percent of the population of the metropolitan area. Results revealed that the reservoir had a storage capacity of 30.88 Mm<sup>3</sup> adjusted to its maximum elevation of 52 m ASL. This value (i.e., 30.88 Mm<sup>3</sup>) is similar to the storage capacity reported on 2015. Considering that approximately 260,000 m<sup>3</sup> of sediments were removed right after the 2015 bathymetry study as part of a dredging effort, we must conclude that a similar amount was deposited as result of hurricane Maria. The fact that the reservoir floodgates were kept open during the hurricane seemed to have prevented greater sediment accumulation.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

Changes/Problems: Access to the reservoirs was restricted since the beginning of the project, initially as result of the catastrophic impact of Hurricane Maria in September 2017, followed by the effect of a series of earthquakes that struck the island at the beginning of 2020, and finally, by the still ongoing impact of the COVID pandemic since the beginning of March 2020. As result, our ability to adhere to the projected schedule and programmed research activities was severely hampered.

Critical Issue

## Family well-being

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### Healthy and Sustainable Families

Project Director

Jaime Curbelo

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

7002470



### Health, Prevention and Early Detection Breast and Cervical Cancer

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**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

In Puerto Rico, 1.2 million people are beneficiaries of government public health insurance. Puerto Rico census data indicate that 7.1% of women of all ages do not have health insurance. According to data from the American Cancer Society, the incidence of breast and cervical cancer in Puerto Rico is 98.5 and 12.6 per 100,000, respectively. These diseases are among the leading causes of death in women in Puerto Rico, being the southwestern region the region with the highest number of uninsured women.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

The Family and Consumer Sciences (FCS) program has a collaborative agreement with the Puerto Rico Breast and Cervical Cancer Prevention and Early Detection Program (PRBCCPEDP), which was funded by the Center for Disease Control and Prevention (CDC) and administered by the University of Puerto Rico, Comprehensive Cancer Center (CCC). As part of this collaboration agreement, Extension Educators of the FCS offered educational activities about women's health and early detection of breast and cervical cancer. The CCC supported the activities by providing educational modules with statistical information about the prevalence of cancers in Puerto Rico, the screening survey, and the analysis of interventions.

Non-formal education on breast, cervical, colorectal and other types of cancers was offered to 1,315 people in Puerto Rico. Educational activities included 1) identification and referring of women of 50 years of age or older who have not had a mammogram in the past two years to the Comprehensive Cancer Center and, 2) identification and referring of women of 21 years of age or older who have not had a Pap smear in the past three years; have no health plan; and that they are residents of the municipalities of the southwest region.

**Briefly describe how your target audience benefited from your project's activities.**

Of the 1,315 people who received non-formal education about breast cancer, cervical cancer, colorectal cancer, and other cancers, 488 women reported to recognize the importance of prevention and early detection of breast and cervical cancer and 15 women without a health plan were referred to the PRBCCPEDP.

Of the audience of the southwest region, 195 were residents of the municipalities: Ponce, Isabela, Sabana Grande, Moca, San Sebastián, Guayanilla, Cabo Rojo, Hormigueros, San Germán, Mayagüez, Rincón, Aguadilla and Peñuelas. From these women: 46 met the criterion of 50 years or older and have not performed a mammogram during the past 2 years; 67 met the criteria of 21 years or older and had not had a Pap test during the last 3 years; and 1 female participant reported not having a health plan. All 195 women received an early detection test.

**Briefly describe how the broader public benefited from your project's activities.**

Having the collaboration of the PRBCCPEDP contributes to expands Extension non-formal education to populations that lack access to information and educational services for prevention and early detection of cancers. PRAES and PRBCCPEDP have a close communication that has allowed us to expand education through social networks and other mass media. In 2022, 6 short educational videos related to cervical cancer and 4 for breast cancer with access to our audience and the public in general were developed.

Critical Issue

## Food safety, science and technology

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### Controlled Fermentation Studies in the Manufacture of Specialty Coffees

Project Director

Javier Huertas

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1025450



### **Annual Results-Controlled Fermentation Studies in the Manufacture of Specialty Coffees**

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**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

This project is focused on the improvement of the aroma and flavor characteristics of specialty coffees made with coffee varieties of Puerto Rico, by using controlled fermentation in combination with available commercial yeast strains as fermenting microorganisms. These techniques will allow better reproducibility of final product characteristics and reduce the possibility of contamination with mold and bacteria that can be detrimental for public health.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Using the protocols established last year, experiments were done to evaluate the capacity of mucilage removal by selected commercial yeast strains. The experiments were carried out under a 12 x 2 experimental design, with twelve yeast strains used in combination with two thermal treatments (that is, coffee fruits with and without previous pasteurization). The idea was to evaluate the performance of yeasts alone, and in the presence of other microorganisms of the natural flora of coffee. From the results obtained so far, it seems that the yeasts used, by themselves, are not able to remove the mucilage, evidencing the need of other microorganisms to perform this function. We understand that microorganisms present on the surface of the coffee fruits (mainly bacteria) break down the mucilage into simpler carbohydrates, which are then used by the yeasts during their metabolic processes. We have expanded the scope of the research to try to isolate and identify the main organisms which are directly responsible for the initial degradation of the mucilage, with the intention of preserving them for further study and use, as part of controlled fermentations. From the experiments carried out, it seems that there are significant differences between treatments of some commercial yeasts, when combined with microorganism of the natural flora, on the capacity of mucilage removal. We also continued the efforts related to the design and evaluation of a controlled fermentation system, as described in the research proposal. Among other things, the cost of materials, the simplicity of the assembly, the easiness of use, and fluidity of fruits and coffee beans were considered. The most promising design consists basically of a conical tank where the separation of suitable fruits is carried out, based on their flotation. The suitable fruits will be discharged, by means of a butterfly valve, towards the fruit pulping unit. The pulped beans will then be introduced by gravity into another larger tank, where fermentation will take place. The fermentation will be carried out in submerged liquid consisting of filtered water mixed with adequate amount of yeast paste inoculum. From the bottom of this tank, by means of a flow divider and a separating grid, liquid will be extracted and pumped to the top of the fermenting vessel, obtaining a recirculation that will gently mix the liquid in contact with the coffee beans. Temperature and pH sensors will be connected to the recirculation pipe, as well as an electric heater, allowing adequate temperature control, by means of a microprocessor controlling unit. An injection point will be included in the recirculation pipe to inoculate the tank with the corresponding yeast paste. The fermentation unit will also have a butterfly valve at the bottom, that will permit the discharge of fermented material into a cannister for the final washing of the coffee beans, to complete the mucilage removal process.

**Briefly describe how your target audience benefited from your project's activities.**



The project is still in its experimental stages and there are no relevant results to be reported. However, we expect that the project activities will generate methodologies and procedures that will help to improve the quality and marketability of specialty coffees cultivated in Puerto Rico, which ultimately will benefit local farmers by increasing their potential for greater profits.

**Briefly describe how the broader public benefited from your project's activities.**

The project is still in its experimental stages, and there are no results to be reported. However, we expect that project activities will help to improve the quality and marketability of specialty coffees cultivated in Puerto Rico, which ultimately benefit customers by providing better coffee products, as well as people of rural communities by increasing potential economic growth of those areas where coffee is cultivated.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training and professional development opportunities** - During the reported period, two graduate students and one undergraduate student received training related to the processing of specialty coffees and the experimental methods to be used in their research activities.

**Dissemination** -The project is still in its experimental stages, and there are no results to be reported. However, we are working on the preparation of a Web Page related to the project, that will provide information to farmers and other interested parties related to the harvesting and processing of specialty coffees.

**Plans for next reporting period** - During the next reporting period, we will continue with the evaluation of the effect in the aroma and flavor characteristics of fermented coffees of the Limani variety using the yeast strains with the better mucilage removal capacity (in fermentations without thermal treatment). In these experiments, the beans with mucilage will be immersed in a solution of 20 L distilled water and 50 mL yeast paste. This solution will be prepared by diluting 5 g commercial freeze-dried yeasts in 50 mL of distilled water. The fermentation will proceed for 48 hours. After this, the beans will be washed to completely remove the mucilage. Once this is done, the beans will be dried, until reaching a grain moisture content of 11.5 %. Parchment coffee will be stored in low relative humidity conditions (< 70 %) and adequate temperature (78 °F) until further evaluation by 3 certified trained tasters (Q-graders), using procedures specified by the Specialty Coffee Association of America (SCAA). Additional analysis of roasted coffee samples (with fermented and non-fermented treatments) will be done using SPME and MS-GC to determine the presence of important aroma compounds typically found in coffee. We will finish the construction and validation of the proposed fermenter, for further evaluation using the most adequate yeasts selected. We will also finish and activate, in coordination with the Agricultural Extension Service, the Web Page with general information related to the production of specialty coffees and the results related to the research project.

**Major changes or problems** - Due to unusual climatic conditions (mainly low temperatures) in the geographical area around the Agricultural Experiment Station of Adjuntas, very low yields of the Limaní coffee variety were obtained during the harvesting period. This forced us to use another local variety (Fronton) to perform the experiments for the evaluation of the mucilage removal capacity of the yeasts. Also, the growth of some of the coffee plants planted last year (as part of the project activities) seems to be somewhat affected by both, low temperatures, and the impact of hurricane Fiona. We are planning to sow new plants to replace the ones affected during the next reporting period.

**Other Products-** Oral Presentation:

Huertas, J. (2016). Controlled Fermentations in the Elaboration of Specialty Coffees. Coffee Commodity Annual Meeting, Agricultural Experiment Station, UPR-Mayagüez, Ba. Yahuecas, Adjuntas.

**Manufacturing and marketability of valued added products using goat milk**

Project Director

Leyda Ponce de Leon

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1021261



**Annual Results-Manufacturing and marketability of valued added products using goat milk**

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

In Puerto Rico, goat's milk is an industry that is emerging, in order to be successful in developing this industry it's important to provide training in how to convert this milk in added value products. Due to the differences in composition, goat milk does not behave similar to cow milk. Dairy products made out of goat do not have the same organoleptical characteristics as cow's milk, thus the importance of learning how to develop dairy products using goat's milk.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Two graduate students of the Food Science and Technology program were recruited to work on the development of different products using goat milk such as cajeta (Dulce de Leche) and yogurt. The work involving the cajeta is almost done, we are currently doing sensory analysis and the proximal analysis of the finished products. An undergraduate was working on the developing of a frozen dessert using goat milk; proximal and sensory analysis was done during the months of September to December. Working on this project, we had learned that products made with goat's milk tend to have softer texture. So indeed, formulations used for cow's milk may not work for products with goats milk. With the information gathered in this project, we are planning to offer short courses to all the dairy goat farmers that may be interested.

**Briefly describe how your target audience benefited from your project's activities.**

Any person that wishes to produce goat milk may benefit from the research we are doing. For instance, we obtained data about the composition of goat milk from 5 different farms in Puerto Rico. Milk composition may be different due to climate, nutrition, and breed. Thus the goat milk composition is not the same and this is valuable information that is needed to develop dairy products. Products made out of goat milk do not have the same organoleptical properties as cow's milk thus developing the proper methods to manufacture products is important.

**Briefly describe how the broader public benefited from your project's activities.**

The broader public may benefit because we are working on the development of different products that at the present time are not manufactured in Puerto Rico, this is a very positive activity because we are helping with the food security of the island.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training and professional development opportunities** -Undergraduate and graduate students working on this project have learned how to manufacture cajeta, yogurt and frozen desserts. Also, how to perform proximal, texture and sensory analysis.

**Dissemination of results**- A webinar was held on March 29th, 2022. Two conferences were presented "Dairy Products manufactured with goat milk" and "The role of goat milk in human nutrition".

**Plans for next reporting period** - We are going to start working on the development of a cheese product. A conference is going to be held at the "Colegio de Agronomos of Puerto Rico" on February 18, 2023, the topic is going to be the "Manufacture of yogurt and "dulce de leche" with goat's milk". A short course is going to be held at the end of March about the manufacture of yogurt and dulce de leche at the Dairy Products Laboratory at the University of Puerto Rico at Mayaguez for dairy goat farmers.

**Major changes or problems** -No major changes in approach but we did have some delays on our work due to students strikes during November 2021 and strikes by non-faculty members on August 2022 that limited the access to the lab during a few days. Hurricane Fiona caused that we lost some samples and products due to being without electricity for a week.

**Elaboration of flours, extruded products & chips based on apio (Arracacia xanthorrhiza B.) & plantain as alternatives for using local agricultural products & their marketing**

Project Director

Rosa Chavez-Jauregui

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1017621



**Elaboration of flours, extruded products & chips based on apio (Arracacia xanthorrhiza B.) & plantain as alternatives for using local agricultural products & their marketing**

Final Result

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

The aim of this proposal will be to produce flours and starch for culinary purposes and snacks (expanded extruded products and chips) from local cultivars of apio and plantain and carry out the sensory quality tests and perform surveys of consumer impressions and acceptance of expanded extruded products, chips and products prepared with flours.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

1) **Produce flours for culinary purposes from local cultivars of apio and plantain.** Arracacha flour from storage roots, rootstocks, stems, and from unripe plantain flour have attractive properties and can be used as an alternative for the food industry. 2) **Evaluate the properties of starch isolated from Puerto Rican apio as a strategy to increase this species' use.** Arracacha starch isolated from the storage root, rootstock, and stems exhibit attractive properties and can be used as an alternative for the food industry. Granule size varied significantly in length (4.58 to 10.33  $\mu\text{m}$ ) and width (6.36 to 9.10  $\mu\text{m}$ ), while amylose content ranged from 23.86% (rootstock) to 26.14% (storage root). Paste clarity values for starches ranged from 24 to 42%, revealing more opaque pastes. The estimated glycemic index (eGI) in the root storage, rootstock, and stems were 74.69, 48.62, and 53.71, respectively. Rootstock had the lowest eGI, indicating starch rootstock is a low eGI food and a good dietary carbohydrate alternative for diabetic people. 3) **Compare the chemical and nutritional properties, physical, physicochemical, and rheological characteristics of the prepared flours, starch, extruded products, and chips.** The chemical composition of apio flour ranged from 7.83 to 9.16% moisture, 2.48 to 3.94% protein, 0.60 to 0.77% total fat, 4.89 to 5.25% ash, 2.32 to 2.56% crude fiber and starch content of 70 to 72%. Apio flour prepared from rootstock had the highest bulk density (0.39 g/mL) and a low emulsifying capacity (4.54%). The chemical and functional properties of the stem are very similar to those of rootstock making it a potential for processing. The plantain flour presented 5.6% moisture, 0.47% lipids, 3.69% protein, 1.79% ash, and 88.44% total carbohydrates. Amylose content was 27.78%. Plantain flour had 0.39 g/mL bulk density and 4.67 g/g oil absorption capacity. The chemical and functional properties of flour showed to be potential for processing. The chemical composition of starch was 10 to 12% moisture, 0.21 to 0.29% protein, 0.26 to 0.32% total fat, 0.10 to 0.13% ash, and 94 to 96% starch. Mineral content varied from 10 to 20 mg/100g phosphorus, 1.02 to 1.41 mg/100g iron, 2.77 to 5.07 mg/100g zinc, and 40 mg/100g calcium. Due to the COVID-19 outbreak and drastic lockdown, samples of apio and plantain harvested in spring 2020 were lost and enough apio and plantain could not be harvested the following year to make chips. 4) **Evaluate the quality of expanded extruded products made from apio and plantain and composite blends and chips.** Our work demonstrated that apio can be extruded and used as a high-quality snack. In the optimal process, the maximum expansion ratio (obtained at 11% of moisture and 150°C process temperature) coincided with the best texture. The general acceptance of the apio snack was from 6 to 9 on a 9-point scale which corresponds to 70% of the panelists. 80% of the panelists evaluated the apio snacks in the range between “like slightly” and “like extremely”, indicating that the apio snacks had good acceptability. Data showed that variable parameters of the extrusion process and unripe plantain flour affected the physical properties of puffed snacks. The most expanded snack products with good physical properties can be at 150 °C and 13% moisture. Extruded snacks are a mixture of unripe plantain flour and grits corn (87.5:12:5%) good sources of carbohydrates with good consumer acceptance and potential for high value-added. 5) **Carry out consumer perception assessments of the quality of flours, starch, expanded extruded products, and chips.** 6) **Identify the tuber and plantain processed products with the most potential market in PR.** The results of objectives 5 and 6 are described in this section: The objective of this survey was to determine the preferences of consumers related to apio and plantains fresh or processed. Six hundred consumers answered the survey. Due to the Covid-19 pandemic, the survey was conducted online among University of Puerto Rico employees. **Apio:** 68% of the consumers don't use to consume apio. Of those who consume it, 52% indicate that they eat boiled, 16% soups, 9% stuffed with meat, 5% mashed, and other recipes. Of those who eat apio, 72% consume it occasionally, 23% monthly, and only 6% two-three times a week. Most of them, 55%, used to buy apio in supermarkets. 23% in family or agricultural markets, 9% in each restaurant and they produce it or receive it from a family. They were asked if they were aware that apio was consumed in various forms such as 43%, stuffed with meat; 22%, frozen; 20% apio flour, and 16% chips. 52% get fresh apio regularly, 81% don't get processed apio regularly, 91% indicate that if it were available in the markets, they would buy it, and 95% would support a processed apio industry. **Plantains:** Ninety percent mentioned that they ate plantains. Of them, 43% bought it fresh. 48% mentioned preferring fried (tostones), 16% fried and mashed (mofongo), 10% boiled, and 4% fried sweet plantains. Another 2% mentioned a combination of ways to do it such as: fried, mashed and fried, boiled, baked, ripe plantains shepherd's pie, mangú, mashed, plantain fritters (arañitas), and others. Forty-five percent consume plantains two or three times a week, 30% monthly, 23% occasionally, and 2% daily; 31% consume plantains that they buy in the various supermarkets on the island, 25% mention that they have a plant, or they are given as gifts, 21% buy them in restaurants, and they 20% use to buy them in agricultural and family markets. Just over half (54%) know that the fresh plantain they consume is produced locally. Consumers were asked if they processed plantains in any form, and 66% mentioned consuming plantains in some way. 45% mentioned they used to consume plantain chips. 40% plantain soup and 7%, ripe plantain, 4% or less mentioned plantain fritters and flours. They were asked their opinion about the quality of the processed plantains that they get in the supermarket. 61% indicated that they considered it fair, 30% good and only 9% indicated that they considered it to be of poor quality. 80% indicated that they regularly obtain the processed plantains they seek. A very significant answer was: 99% of those interviewed indicated that if processed plantains were available, they would buy them. 97% mentioned that they would support this industry. **Restaurants:** Due to the loss of employees due to the COVID-19 pandemic, there was no willingness on the part of the number of restaurant owners and/or managers to answer the form about their willingness to buy products made from plantains and apio. We were able to obtain information from 10 restaurants. **Apio:** Only 40% use fresh apio in their restaurants. Those who use it do it with beans, soups, creams, confits, fritters, raw, and even apio whipped cream, it's the main ingredient of my signature dish. None of them use processed apio. The attractions that chefs find in apio are that it tastes amazing and is exotic, a good substitute for potatoes. 100% know that apio is a local product. All of them are willing to incorporate apio into their dishes. The apio products that the interviewed would be willing to buy are flours for soups, cookies, cakes, mashed apio stuffed with meat (Rellenos), apio shepherd's pie, chips, and frozen products, 75% indicated getting apio whenever they wanted. 100% are willing to buy apio if it were available. **Plantain:** All the interviewees use plantains in their restaurants. The most common use was fried seasoned mashed plantains (mofongo or trifongo), 90%; cooked Dominican style mashed plantains (mangú), 20%; plantain fritters, 30%, stuffed plantains baskets, 20%; beans, 10%; ripe plantain shepherd's pie, 10%, soups, 10%; ripe plantain, 10%, and others. Fifty percent use processed plantains in their restaurant. Interviewed considered plantains: versatile, 78%; 44% it's the favorite of the Puerto Ricans; 80% know that fresh plantains are locally produced. 100 of the participants are willing to include it in their dishes processed plantains. We wanted to know what products you would buy, 50% mentioned: plantain flour for general use or baking; ripe plantain shepherd's pie, plantain stuffed fritters (alcapurrias), and chips. 40% mentioned plantain flour for soups and plantain fritters. 80% mentioned that they get fresh plantains regularly and also processed plantains. 100% mentioned that if they had processed plantains available, they would buy them. Currently, I buy whole peeled plantains because it saves me time and minimizes the cost of labor in the kitchen. The owners are always willing to support a processed local apio and plantain industry.

**Briefly describe how your target audience benefited from your project's activities.**

The principal target audience served by this project is scientists in the public sector working with technology for processed vegetables. Information will be delivered to the first target audience through publications, presentations in scientific meetings, and informal discussions at these meetings.

**Briefly describe how the broader public benefited from your project's activities.**

Other important target audiences are growers, consumers of fresh products, and restaurants in Puerto Rico.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training and professional development opportunities** - One master-level graduate student and two undergraduate students participated in this research this year. Students have been able to improve their skills in the use of various laboratory equipment and data analysis. A total of 8 undergraduate and 1 postgraduate minority student were mentored during the 4-year duration of the project. Each student carried out either independent or guided research in the area of food technology.

**Publications:**

Oral presentation: Natalie N. Rivera-Agosto and Rosa N. Chávez-Jáuregui. Development of extruded ready-to-eat snack based on unripe plantain flour and corn grits. 4th Edition of Euro-Global Conference on Food Science and Technology (Online Event) during September 12-13, 2022. M.S.

Thesis: Natalie N. Rivera Agosto. Development of Arracacia xanthorrhiza-based extrudate product using cysteine and butyric acid as aroma precursors. The Master thesis will be published in March 2023.

Critical Issue

## Food security, plant & animal systems

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### Breeding Phaseolus Beans for Resilience, Sustainable Production, and Enhanced Nutritional Value

Project Director

Elva Consuelo Estevez De Jensen

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

7001811



### **Annual Results-Breeding Phaseolus Beans for Resilience, Sustainable Production, and Enhanced Nutritional Value**

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**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

The successful production of beans in Puerto Rico requires the availability of locally adapted cultivars. This project uses conventional plant breeding techniques and marker-assisted selection to develop cultivars having greater resistance to major biotic and abiotic constraints to production. Plant pathologists monitor virulence patterns of pathogens and participate in the identification of new sources of resistance to diseases.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

The specific objectives of project H-351 are: (1) Conduct a bean breeding program by crossing promising parents and selecting lines in the F2 to F6 generations for adaptation, agronomic traits and disease resistance, (2) Evaluate the performance of advanced generation breeding lines on experiment stations and farms, (3) Screen breeding lines with molecular markers linked to disease resistance genes, (4) Study the genetic variability of endemic plant pathogens and detect the presence of emerging bean diseases.

As part of the M.S. degree thesis research of Yohari E. Torres-González, evaluated the reaction of 26 common bean lines to *Fusarium solani*. Disease symptoms were assessed after inoculation with isolate 19-00514. In the screen house trial, two white bean cultivars 'Bella' (1.5) and 'Benítez' (1.5), released by the University of Puerto Rico, had resistant scores.

Snap bean lines segregating for multiple virus resistance were planted at the Isabela Substation in January 2022. Individual plants were selected based on results from screening by Dr. Tim Porch using molecular markers in the Intertek SNP platform. Lines were selected that possessed the *bgm-1* gene and the BGY8.1 QTL for BGYMV resistance and the *I* and *bc-3* genes for resistance to BCMV and BCMNV. Several of the snap bean breeding lines also possess the SAP6 QTL for resistance to common bacterial blight. If possible, the lines will be screened for reaction to BCMNV under greenhouse and field resistance to BGYMV in Honduras.

The UPR pinto breeding line PR1572-19 was crossed with the Great Northern cultivar ‘Panhandle Pride’ from the University of Nebraska. This Great Northern cultivar has improved plant architecture and high levels of resistance to common bacterial blight (SAP6 and SU91 QTLs for CBB resistance). F2 seed was produced in a screenhouse at the USDA-ARS Tropical Agriculture Research Station by Dr. Tim Porch. Individual plants were selected from the F2 nursery that was planted at the Isabela Substation in February 2021. F3 lines were screened by Dr. Tim Porch using the Intertek SNP marker platform to identify lines having genes for resistance to BGVMV, BCMNV, rust and common bacterial blight. Based on the results from the screening with molecular markers, F4:5 lines identified by markers to possess the *I* and *bc-3* resistance genes, will be screened for reaction to BCMNV.

A yellow bean yield trial was planted at Isabela in January 2022. The trial included 5 entries (PR2105-2, 3, 6, 10 and 16) with the *bgm-1* gene and the BGY8.1 QTL for BGVMV resistance and the *I* and *bc-3* genes for resistance to BCMV and BCMNV. These lines had an immune reaction with the NL-3 strain of BCMNV.

Farmers in Puerto Rico have reported losses in bean yield due to angular leaf spot (ALS) caused by *Pseudocercospora griseola* (Sacc.) Crous & U. Braun. This may be due, in part, to asynchronous plantings of beans for green-shelled production that allow the build-up of disease pressure. Rotation of beans with non-host crops should be a recommended production practice. The white bean breeding line PR1627-8 was derived from the cross ‘Verano/ALS9951-101-R1’. Mean seed yield of PR1627-8 was 2,087 kg ha<sup>-1</sup> across eight field trials conducted in Puerto Rico and Haiti. PR1627-8 was resistant to angular leaf spot and had moderately resistant reactions to common bacterial blight in field trials planted at the Isabela Substation. Seed from two individual plant selections from PR1627-8 were sent to Dr. Talo Pastor-Corrales, USDA-ARS Research Plant Pathologist at Beltsville, MD, for screening with specific races of the rust pathogen. Results from the evaluation suggests that PR1627-8 has the *Ur-5* rust resistance gene. PR1627-8 also has the *bgm-1* gene for BGVMV resistance and the *I* gene for resistance to BCMV. PR1627-8 was crossed with the white bean breeding line PR0608-81A which has the *Ur-11* rust resistance gene. Bean lines that combine the *Ur-5* and the *Ur-11* rust resistance genes should have broad and durable resistance.

The black bean breeding line PR1564-20 has the *bgm-1* gene and the BGY8.1 QTL for resistance to BGVMV, the *I* and *bc-3* genes for resistance to BCMV and BCMNV and the *Ur-11* gene for rust resistance. This line has performed well in the Dominican Republic and is under consideration for release as an improved germplasm line.

The black bean line PR1933-5 and the dark red line PR1933-7 continue to be the best Mesoamerican sources of bruchid resistance in the UPR bean breeding program. These lines also have the *bgm-1* gene and the SW-12 QTL for BGVMV resistance and the *I* and *bc-3* genes for BCMV and BCMNV resistance. Un-fumigated seed from replicated field trials planted at the Isabela Substation in February and June 2021 and January 2022 including PR1933-5, PR1933-7, Bella and Verano was stored in plastic trays to observe the rates of natural infestation. Results from three growing seasons were consistent in that after three months of storage PR1933-5 and PR1933-7 had lower incidences of infestation and less seed damage from the common bean weevil than the susceptible checks Verano and Bella. PR1933-5 and PR1933-7 are under consideration for release in 2023 as improved bean germplasm. Lines PR1933-5 and PR1933-7 were crossed with elite Mesoamerican bean cultivars from Central America and the Caribbean.

F6 Andean lines with red mottled, white, yellow and light red kidney seed were screened by Dr. Porch using Intertek SNP markers for resistance to BCMV (*I* gene), BGVMV (*bgm-1* gene and BGY8.1 QTL) and common bacterial blight (SAP6 QTL). Some of the lines were also screened at North Dakota State University using a SNP marker for the APA locus which is associated with bruchid resistance. These lines were screened in the laboratory during the winter of 2022 for bruchid resistance. molecular marker.

Bruchid resistant Andean lines from the first cycle of selection were screened for reaction to the NL-3 strain of BCMNV. Eight of the lines had reactions of restricted vein necrosis which indicates the presence of *I*, *bc-ud* and *bc-1* genes for resistance to BCMNV and BCMNV. Twenty-five dark and light red kidney and white Andean lines from the second cycle of recurrent selection were selected for additional evaluation based on their resistance to bruchids and genes for resistance to BGVMV, BCMV and BCMNV.

‘Rosalinda’, a multiple virus resistant pink bean line (PR1519-25) adapted to the humid tropics, was developed, and released cooperatively by the University of Puerto Rico (UPR) and USDA-ARS. ‘Rosalinda’ is resistant to BGVMV, BCMV and BCMNV. Rosalinda produced a mean seed yield of 2,649 kg ha<sup>-1</sup> in seven trials conducted at the Isabela Substation from 2014 to 2019. The mean seed yield of Rosalinda was significantly higher than the check cultivar ‘Verano’. Mean seed yields of Rosalinda were stable across trials, ranging from 2,004 to 3,518 kg ha<sup>-1</sup>. A manuscript describing the release of Rosalinda was submitted to the *J. Agric. of the Univ. of Puerto Rico*. Rosalinda represents the first release of a Mesoamerican race pink bean cultivar. A small seed increase ‘Rosalinda’ was harvested at the Isabela Substation in April 2022.

### **Briefly describe how your target audience benefited from your project's activities.**

In recent years, the project has released black, pinto and white bean cultivars with resistance to BGVMV, BCMV, common blight and greater tolerance to low fertility soils. The release of these varieties should reduce loss in yield and seed quality caused by disease and permit more bean production during the hot and humid summer months. Demand for seed of locally developed and released bean cultivars (Bella, Verano, Beniquez, Badillo) exceeds demand.

### **Briefly describe how the broader public benefited from your project's activities.**

A major goal of the UPR bean breeding program is to develop locally adapted bean cultivars that can be used to increase food security in Puerto Rico. Recent releases of bean cultivars in Puerto Rico have resistance to major diseases and a more erect plant architecture that would allow direct harvest with a combine. Mechanization of the cultivation and the harvest of the crop is considered necessary for the efficient production of dry beans and to be competitive with imported dry beans. Dry beans can be produced in rotation with crops such as sorghum [*Sorghum bicolor*



(L.) Moench], maize (*Zea mays* L.), soybeans [*Glycine max* (L.) Merr.] and rice (*Oryza sativa* L.) that are widely consumed in Puerto Rico and are currently imported. The same agricultural equipment can be used to cultivate and harvest these crops. Farmers can compete with producers in temperate climates by sequential multiple cropping of dry beans with other crops.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

- Project personnel provided technical training concerning cultivar development and the management of bean diseases and pests to University of Puerto Rico extension agents in a workshop to be held in April 2022 at the Fortuna Substation.

) - Project personnel collaborated with Dr. Ermita Hernández, Leader of the Vegetable and Basic Grain Commodity Group and UPR Extension Specialist, in the preparation of a Bean Production Manual that will be posted on the website of the commodity group.

- Field trials will be planted at the Isabela Substation to advance generations and test bean breeding lines for yield potential, adaptation and disease resistance. Screenhouse and laboratory facilities at the Fortuna Substation will be used to screen bean lines for disease resistance and to monitor bean diseases. More specific plans are described in a previous section.

Red mottled beans and light red kidney beans are among the most popular Andean seed types in the Caribbean. A manuscript for the *Journal of Plant Registrations* near completion describing the release of PR1654-7, a multiple virus and CBB resistant red mottled bean germplasm line adapted to the humid tropics. PR1654-7 was developed and will be released cooperatively in during FY22 by the UPR Agricultural Experiment Station, the Instituto Dominicano de Investigaciones Agropecuarias y Forestales and the USDA-ARS. PR1654-7 possesses the *I* and *bc-3* loci that confer resistance to BCMV and BCMNV, the *bgm-1* gene for resistance to BGYMV, and the SAP 6 QTL for resistance to CBB. PR1654-7 produced a mean seed yield of 1,597 kg ha<sup>-1</sup> in eight trials planted in Puerto Rico, the Dominican Republic and Haiti which was comparable to the check line PR1146-138. PR1654-7 has a commercially acceptable red mottled seed type and should serve as a useful source of resistance to BGYMV, BCMV, BCMNV and CBB for Andean beans produced at lower altitudes of the tropics.

: (Journal publications):

Beaver, J.S., Martínez Figueroa, H., Godoy Lutz, G., Estévez de Jensen, C., Porch, T.G., & Rosas, J.C. 2022. Breeding for resistance and integrated management of web blight in common bean. *Crop Science*. 62:20-35.

Sadohara, R. Izquierdo, P., Couto Alves, F., Porch, T.G., Beaver, J.S., Urrea, C.A. & K. Cichy. 2022. The *Phaseolus vulgaris* L. Yellow Bean Collection: genetic diversity and characterization for cooking time. *Genet Resour Crop Evol* (2022) 69:1627–1648.

Myers, J.R., P.M. Kusolwa and J.S. Beaver. 2021. Breeding the common bean for weevil resistance. *Chronica Horticulturae* 61:16-20.

Soler-Garzón A., Oladad A., Beaver J., Beebe S., Lee R., Lobaton J.D., Macea E., McClean P., Raatz, B., Rosas J.C., Song Q. and Miklas P.N. 2021. NAC candidate gene marker for *bgm-1* and interaction with QTL for resistance to *Bean Golden Yellow Mosaic Virus* in common bean. *Front. Plant Sci.* 12:628443.

Beaver, J.S., A. González-Vélez, G. Lorenzo-Vázquez, R. Macchiavelli, T.G. Porch, C. Estevez-de-Jensen. 2021. Performance of Mesoamerican bean (*Phaseolus vulgaris* L.) lines in an unfertilized oxisol. *Agronomía Mesoamericana* 32:701-718.

(Other publications):

Torres-González, Y., Estévez de Jensen, C., Beaver, J.S., T.G. 2022. Resistance of common bean lines to root rot caused by *Fusarium solani*. *Ann. Rep. Bean Improv. Coop.* 65:25-27.

Porch, T.G. and Beaver, J.S. 2022. Response of tepary bean breeding lines and entries of the tepary diversity panel (tdp) when infested with the common bean weevil (*Acanthoscelides obtectus*) *Ann. Rep. Bean Improv. Coop.* 65:117-118

Porch, T.G., J.S. Beaver, J. Arias, G. Godoy-Lutz. 2021. Response of tepary beans to Bean golden yellow mosaic virus and powdery mildew. *Annual Report of the Bean Improvement Coop.* 64:73-74.

As a contribution to Regional Hatch Project W-4150, the project plants a winter nursery for collaborating U.S. bean breeding programs. The 2021-2022 winter nursery planted at Isabela Substation includes > 4,000 lines from North Dakota State University, Michigan State University, the University of Nebraska and USDA-ARS bean breeding program.

### **Added value to create and expand marketing opportunities for crop producers.**

Project Director

Jaime Curbelo

Organization



### **Providing tools through PRAES to enhance coffee quality and marketing opportunities**

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

For many years small-scale coffee producers in Puerto Rico have sold their coffee harvest to a middleman producer, which does not necessarily result in the best economic benefit to the farmers. Lack of knowledge on how to improve the quality of their coffee products has limited their ability to access growing coffee markets and customers looking to buy locally produced quality coffee. Therefore, a group of Extension Agents from PRAES created an educational project called “Los Cafetaleros” with the main objective of training local producers about improving farm practices required for quality coffee.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

The Golden Cup Competition, an annual event that provides producers with the opportunity to cup their coffee and learn the attributes of their product, has been the main venue that contributed to the success of our educational project. This project has undertaken extensive educational workshops and seminars that have equipped local producers with the appropriate knowledge to improve their product at the farm and cup level. During this year, 2 workshops have been given on how to prepare a coffee sample to compete for the Golden Cup award. These activities included hands on training in the areas of coffee berry physiology, fermentation, sun-dried processes, storage, and green coffee analysis. Additional training included recommended practices about coffee harvesting, coffee processing, roasting, green coffee analysis and cupping, and access to better markets. Farm visits have allowed us to demonstrate and teach farmers and farm workers, on a one-to-one basis, how to process quality coffee. The success of these activities has provided better knowledge, increased product value and revenues for many farmers.

**Briefly describe how your target audience benefited from your project's activities.**

During this period, the project has impacted 361 coffee farmers. Many farmers have acknowledged to recognize the importance of producing and selling quality coffee to increase their income. As a result of the PRAES group effort, 54 producers have improved the quality of their coffee in the farm and 100 farmers have developed coffee roasting quality skills and added value products. Likewise, after increasing their knowledge, implementing the recommendations, and obtaining the expected results, many of these farmers reported feeling more proudly about their products, serving as incentive to reach out to new markets and customers. Furthermore, those farmers awarded with the Golden Cup prize have participated in international coffee quality expos in the United States, such as the Specialty Coffee Expo, and gain additional knowledge about specialty coffee. Other producers have had the opportunity to show case their quality coffee products at national coffee expos in Puerto Rico which have empowered them to enter new markets, customers, and higher profits. There have been more than 15 farmers that after participating in our program, were able to acquire new quality coffee equipment to add value to their products.

**Briefly describe how the broader public benefited from your project's activities.**

Our program, aside from educating coffee farmers, has also impacted professionals in the areas of family and consumer sciences from the University of Puerto Rico Extension program. The professionals were given a 3-day intensive training course in the area of coffee quality. These professionals acquired vast knowledge on how to understand specialty coffee vs commercial coffee through activities such as green coffee analysis, cupping, roasting, and packaging. Also, this project has extended to local shopping malls and other venues where we have educated the general public with quality coffee exhibitions and training. For the past 3 years, our project has exhibited at the Puerto Rico Coffee & Chocolate Expo, a venue that has given us the opportunity to teach the public in general on quality coffee production, management, processing and roasting.

### **Fertility and embryo characterization of slick hair Holstein cattle**

Project Director  
Veronica Negrón  
Organization  
University of Puerto Rico Mayaguez Campus  
Accession Number  
1025357



### **Fertility and embryo characterization of slick hair Holstein cattle**

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Results of the proposed work improve our knowledge related to the effects of slick hair traits on reproduction and whether genetic selection for thermotolerance would diminish economic losses associated with heat stress. Moreover, this study is one of the first to describe the reproductive parameters of slick hair Holsteins compared to wildtype. This knowledge provides an alternative for dairy farmers to include an animal with superior thermotolerance ability in their herd and increase their farm productivity year-round.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Major activities include ultrasound images of the ovarian structures that allow us to track progressive changes in respect to the estrous cycle. This will allow us to compare slick vs wildtype and help us answer whether the slick gene allows the animal overcome the negative effects that heat stress has on the ovary and estrus expression. This is part of the first and third proposed goals. Additionally, gene expression data from uterine swabs was analyzed and presented as part of a students' MS thesis. In summary, there are detectable differences in gene expression that may indicate that the slick cow is more fertile than the wildtype when exposed to tropical warm weather.

**Briefly describe how your target audience benefited from your project's activities.**

The academic community is the first to be positively impacted by our results as this was presented in part as an MS students' thesis. Additionally, academic and industrial communities will continue to benefit from the increase in reproduction knowledge as we continue to present our data. Farmers will ultimately benefit as they will have yet another factor to consider when selecting for the better animal and when searching for alternatives to decrease their economic losses due to heat stress impact on Holstein cows.

**Briefly describe how the broader public benefited from your project's activities.**

The average consumer of dairy products will benefit from these results in an economical aspect. By including a heat tolerant animal in the herd, economical losses related to heat stress will decrease. Also, the broader public will have the reassurance that the welfare of dairy cows is improved given that slickhair Holsteins have the ability to mitigate heat stress and thus are less affected by the negative impact from it.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

Students and technicians continue to being trained in rectal palpation, blood sample collection and ultrasound images to execute the experimental protocols for this study.

Results were presented and discussed as part of Bianca Ortiz MS thesis titled "Evaluation of gene expression in endometrial epithelial and immune cells and segregation of candidate genes polymorphisms in Slick and Non-Slick cattle" (December 2022).

Heifers continue to undergo estrous synchronization protocols to expand the current data set including ovarian structures patterns throughout the cycle. Current data is being analyzed to verify statistical differences in the values obtained for selected variables (estrus expression, pregnancy, number of follicles, size of follicles, to mention a few).

Due to changes in student class schedules, research plan was delayed by a couple of months. However, we expect we will be able to continue the studies without major changes at the moment.

Negrón-Pérez VM and Aponte A (pending approval. Submitted June 2022; revised manuscript submitted November 2022) Developmental and Reproductive Performance Differences of the Slick Hair Holstein. J. Agric. Univ. P.R.; Brief Research Report.

Ortiz-Uriarte, Bianca (submitted December 2022) In part of UPR Mayagüez, Master's Thesis.

General information, and representative images of the projects have been mentioned on the Agricultural Experiment Station at Gurabo social media pages (@eeagurabo on Facebook, Instagram and Twitter).

Closing Out (end date 06/12/2024)

**Effects of using an automated milk feeder to deliver an accelerated growth feeding protocol on the weight gain and future milk yield in slick and wild-type Holsteins calves**

Project Director

GUILLERMO ORTIZ

Organization

University of Puerto Rico Mayaguez Campus

Accession Number



## Annual report - Effects of using an automated milk feeder to deliver an accelerated growth feeding protocol on the weight gain and future milk yield in slick and wild-type Hol

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

One of the greatest challenges of dairying in the tropical regions of the world is heat stress. Since the principal dairy breeds have been mostly selected from temperate regions, climate change might increasingly expose dairy cows in all parts of the world to chronic heat stress, negatively affecting dairy profitability. To minimize the effects of heat stress, genetic development of heat-tolerant breeds is a must, and research on intrinsic differences exhibited by heat tolerant breeds would be invaluable in the quest to genetically select for heat stress tolerance.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

So far we have had reproductive synchronizations events that have resulted in (31+18+12) calves that have been part of nutrition trials comparing growth rates between slick and wild type dairy cattle. Of those 61 calves, 31 calves, now heifers, were synchronized and inseminated with a heterozygous Slick bull that is also polled. Concomitantly, 36 adult cows were also be synchronized and inseminated with a heterozygous Slick bull that is also polled. The offspring of these cows is currently been part of additional nutrition trials, but in this occasion we are comparing homozygous Slick calves against heterozygous Slick and wild type calves. Since August 2022 we have been finally using the automatic milking system (Feeding robot) and we are maximizing resources by also comparing the growth of wild-type animals growing under robotic management with the growth of wild-type animals growing under manual labor and with less space allotment per calve.

**Briefly describe how your target audience benefited from your project's activities.**

We are documenting the growth and efficiency of Slick and Wild-Type dairy calves under an accelerated growth feeding protocol under heat stress conditions in terms of weight gain, feed efficiency, skeletal development, and health status. We will be able to determine in economic terms if Slick calves have an advantage over WT animals and the costs and challenges of an accelerated growth feeding protocols. Also we already have a line of dairy farmers waiting for our feeding robot to start functioning, making the university dairy a showcase of the latest feeding technology.

**Briefly describe how the broader public benefited from your project's activities.**

Feed efficiency evaluates the relative ability of bovines to turn feed nutrients into true tissue or milk. This selection criterion must always be contemplated when selecting dairy animals and is extremely important when feed prices are high and milk prices are low. Therefore and important tool to improve profit margins for dairy producers in Puerto Rico is to increase the feed efficiency of dairy animals used in Puerto Rico in order to optimize (decrease) the age at first calving and increase the milk produced from every kg of feed and lifetime milk production. Moreover, dairy cattle with higher feed efficiencies will excrete fewer nutrients, minimizing the environmental impact of dairy farms in Puerto Rico, where many are already struggling to comply with manure application regulations. If we documented that Slick dairy cows have better feed efficiencies than Wild-Type animals, dairy farmers in Puerto Rico would be advice to adopt this dairy "breed" ultimately benefiting their bottom line.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

- So far more than 60 undergraduate student have participated in the project as undergraduate research assistants. Moreover, currently four graduates students are working in the various aspects of this research project. They all have been trained in estrous synchronization protocols, health monitoring, animal welfare, data gathering and analysis, nutrition and animal welfare.

Moreover, all of tar county extension agents of Puerto Rico that work with dairy cattle were trained in the advantages and challenges of the use of automatic calves feeding systems.

- At the Annual Meeting of the Agricultural Sciences Society of Puerto Rico (SOPCA), four of the students involved in this research project presented the following abstracts:

*Characterization of rumen and hindgut microbial communities in slick and wild-type Holstein calves in a tropical climate.*

Natalie M. Mele?ndez-Va?zquez, Mariela Torres-Rivera, Guillermo Ortiz-Colo?n, and Filipa Godoy-Vitorino

*Efecto de la disponibilidad de espacio en la salud, en la ganancia en peso y el desarrollo esqueletal en becerros Holstein.*

, Cristian R. Perdomo Garcí?a, Carolina I. Rivera Camacho, Ange?lica M. Silva Perea, Mariela D. Torres Rivera, Ge?nesis Agosto Burgos y Guillermo Ortiz-Colo?n

Average daily gain and skeletal growth of slick and wild-type Holstein heifers raised on a semi-intensive rotational grazing system. **Carolina I. Rivera Camacho**, Cristian R. Perdomo Garci?a, Vero?nica A. Rodri?guez Burgos, Mariela D. Torres Rivera, Grecia D. Rosario Garci?a, Ange?lica M. Silva Perea, Vero?nica M. Negro?n Pe?rez, and Guillermo Ortiz Colo?n

Effects of using an accelerated growth feeding protocol on body weight, 39 skeletal development and health score in slick and wild-type Holstein calves from birth until weaning. **Mariela Torres Rivera**, Marieli Ruiz Corte?s, Cristian R. Perdomo Garci?a, and Guillermo Ortiz Colo?n

**Plans for next reporting period** - Second lactation trial will take place next August 2023. We will continue with the growth trials of the calves and heifers. The ultimate goal if to have a herd composed of homozygous and heterozygous Slick animals, to compare against Wild-Type animals. We will share our results next stakeholders meetings, this next April 2023.

**Major changes or problems** - Hurricane Fiona damage Puerto Rico power grid, and the private company (LUMA) repair response was slow and disorganized. Consequently, the University Dairy Farm was without power for at least 3 weeks, and eventually our energy generator failed and we lost all the blood samples and some of the feed and milk samples. We aspire to re-take and hopefully analyzed the blood samples from the current experiments.

#### **Publications:**

Other publications, conference papers and presentations:

**Rivera-Camacho Carolina I.**, Cristian R. Perdomo-Garci?a, Vero?nica A. Rodri?guez-Burgos, Mariela D. Torres-Rivera, Grecia D. Rosario-Garci?a, Ange?lica M. Silva-Perea, Vero?nica M. Negro?n-Pe?rez, and Guillermo Ortiz-Colo?n. 2022. Average daily gain and skeletal growth of slick and wild-type Holstein heifers raised on a semi-intensive rotational grazing system. Proceedings of the Annual Meeting of the Puerto Rican Society of Agricultural Sciences. 47:38.

**Rosario-García Grecia D.**, Cristian R. Perdomo-Garci?a, Carolina I. Rivera-Camacho, Ange?lica M. Silva-Perea, Mariela D. Torres-Rivera, Ge?nesis Agosto-Burgos y Guillermo Ortiz-Colo?n. 2022. Effect of space availability on health, weight gain and skeletal development in Holstein calves. Proceedings of the Annual Meeting of the Puerto Rican Society of Agricultural Sciences. 47:12.

**Ruiz-Cortés, Marieli**, Natalie M. Mele?ndez-Va?zquez, Mariela Torres-Rivera, Guillermo Ortiz-Colo?n, and Filipa Godoy-Vitorino. 2022. Characterization of rumen and hindgut microbial communities in slick and wild-type Holstein calves in a tropical climate. Proceedings of the Annual Meeting of the Puerto Rican Society of Agricultural Sciences. 47:11.

**Torres-Rivera, Mariela**, Marieli Ruiz Corte?s, Cristian R. Perdomo-Garci?a, and Guillermo Ortiz-Colo?n. 2022. Effects of using an accelerated growth feeding protocol on body weight, 39 skeletal development and health score in slick and wild-type Holstein calves from birth until weaning. Proceedings of the Annual Meeting of the Puerto Rican Society of Agricultural Sciences. 47:39.

#### **Other Products/Outputs:**

**Activities:** *Along with the help of statistician Cristian R. Perdomo-Garci?a experiments have been analyzed. Moreover, formal undergraduate research experiences have been integrated into project H505.*

**Events:** *The automatic feeding station at the Agriculture Experimental Station now serves as a demonstration site of calf management where we have conducted workshops and trainings for students (undergraduate & graduate), agriculture extension agents, famers and other professionals.*

**Services:** Project H505 has facilitated consulting, counseling, and tutoring to dairy farmers interested in the automatic feeding and management of dairy calves.

**Products:** A curricula for calf management under automatic feeders have been developed and now we have such an equipment (feeding robot) for demonstrative purposes. We have established a collaboration with economist Jon Winsten, of Winrock International, that will help us develop and economic model for the implantation of robotic milk feeders in Puerto Rico. A group of 20+ students now are trained in the use of automatic milk feeders and calf management in such systems. Four students are completing their masters 'degrees in animal science trough project H505.

### **Evaluation of selected crop vars. & weed management practices for organic & agroecological production systems: integrating environmental, social & economic impact assessments**

Project Director

Alfredo Aponte-Zayas

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1021262



**Evaluation of selected crop vars. & weed management practices for organic & agroecological production systems: integrating environmental, social & economic impact assessments**

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project evaluates the adaptability of current plant varieties developed by the Agricultural Experiment Station in Puerto Rico to the organic or agroecological cropping systems. This project will evaluate varieties of selected crops for adaptability to an organic production system and weed control strategies that fit organic crop production. Socioeconomic studies that update the profile and constraints faced by organic/agroecological stakeholders are also needed to formulate policies targeting limitations. Through a sample survey of stakeholders that have participated in the AEXS organic farm visits and demonstrations, we will document how the information provided by these farms is used and update current information needs of stakeholders to guide future research and extension initiatives. This project aims to strengthen organic/agroecological farming in Puerto Rico through the improvement and dissemination of crop production practices adapted to organic systems, through better characterization of agroecological stakeholders research and education needs, and through the exploration of successful models and collaborative initiatives for furthering this type of farming on the island.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Visual field observations were performed on the incidence of pests and diseases during the early plant establishment. The varieties that were best adapted to organic systems were: beans var “Beniquez”, cucumber var “Gurabo”, cowpea var “Gorda”, eggplant var “Rosita”, sweet cherry pepper var “Bonanza”, tropical pumpkin var “Taina Dorada” and sweet potato var “Pujols”.

Field observations to control weed pressure- The treatments using bio-degradable plastic mulch and hay mulch were the best suppressing weeds in Lajas Puerto Rico. In Gurabo Puerto Rico the weed suppression trial will be established on February 2023 due to the climate conditions. A project extension will be requested in April 2023 due to these weather-related delays.

A database was created with the voluntarily provided contact information of visitors and participants in organic farms project’s activities, and of buyers of organic seeds at Lajas substation. A preliminary profile of these stakeholders was prepared with the available information on municipality of residence, occupation, and reason for visit or educational activity attended. A questionnaire for a follow-up survey of these audiences was prepared and is currently being tested. Work has also continued in an annotated bibliography of organic farms projects results and identified knowledge gaps.

**Briefly describe how your target audience benefited from your project's activities.**

The targeted audience of this project include agroecological farmers, undergraduate and graduate students, scientists and personnel of the Cooperative Extension Service. Preliminary results have been demonstrated to farmers and students through educational courses during the last three years. The best varieties of different crops have been already identified and recommended to farmers that are operating organic or agroecological farms. Eventually technical publications and documentation will be available for agricultural agents and farmers. The project provided an assistantship for a graduate student that collaborated in the establishment of the project’s database and in the analysis of the information gathered. Also, the project’s rationale and preliminary profile of organic farms stakeholders was presented in an international Social Science congress in which colleagues from Extension provided suggestions on possible collaborations to expand the impact of our land grant’s agroecological programs.

**Briefly describe how the broader public benefited from your project's activities.**

The proposed project expects to strengthen sustainable agriculture and organic farming in Puerto Rico through a multidisciplinary effort to summarize previous results, address research gaps, document impacts of research farms, and explore future paths and initiatives to extend agroecological farming in the island. Specifically, this project will evaluate varieties of selected crops for adaptability to an organic production system and weed control strategies that fit organic crop production. Through a sample survey of stakeholders that have participated in the AEXS organic farm visits and demonstrations, we will document how the information provided by these farms is used and update current information needs of stakeholders to guide future research and extension initiatives. When results from the project’s trials are available, stakeholders interested in strengthening organic and agroecological farming in Puerto Rico will have updated information on the most promising varieties for organic systems of selected vegetables and root crops. Also, Information gathered through the profile and planned survey of participants in program activities will help guide future research and extension initiatives in UPRs College of Agricultural Science.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

- Two scientific research technicians are involved in the project. Both have been working in all the process of establishment, maintenance, and data compilation. They are in charge of the work schedule and this has been a great opportunity for their career development in agriculture. The project provided a research assistantship to a graduate student who was finishing his MA thesis, and mentorship on topics related to food security and agroecological farming in Puerto Rico.

- ) - Most of the outreach activities have been related to educational activities in agroecological classes to students and farmers. However, expected project outcomes include a publication documenting those technologies that have been evaluated, and a conference to disseminate results. As mentioned above, the project’s rationale and preliminary profile of organic farms stakeholders was presented in an international Social Science congress in which Extension colleagues from Puerto Rico and elsewhere participated. (See oral presentation reference in Publications section).



- During the next reporting period a project extension request will be prepared to finish the research trials at Gurabo and for the planning and execution of a conference on future research and extension initiatives within the College of Agricultural Sciences. We will also be working on research publications to the different stakeholders and on executing the planned survey of participants on farms activities. Results will be coded, preliminary analyzed and presented at a professional, local, or regional meeting.

- No major changes are expected. However, there has been some delay on finishing research trials in Gurabo Puerto Rico due to excessive rain during the last 5 months. The last trial will be planted in February 2023 in Gurabo Puerto Rico.

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Carro-Figueroa, Vivian. 2022. "Logros y desafíos en el desarrollo de un programa de investigación en agricultura orgánica en la Universidad de Puerto Rico: el caso de las fincas orgánicas de la Estación Experimental Agrícola". Oral presentation in the 9th Latin American and Caribbean Social Science Conference, National Autonomous University of Mexico (UNAM), Mexico City, June 10.

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From February 2023 to June 2023 a group of 25 agroecology and organic students will be planting and working with the selected varieties to show them the best management practices to grow those crops. On May 18, 2023, we will be participating at the vegetable producers commodity meeting and presenting results related to the research. After completion of research activities, we will start working on peer reviewed publications, conferences and other technical fact sheets for farmers and stakeholders.

### **Long-term trial: Fertility, yield, quality and persistence of tropical improved grasses**

Project Director

Alfredo Aponte-Zayas

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1021260



### **Long-term trial: Fertility, yield, quality and persistence of tropical improved grasses**

#### **In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Most of the information used to provide technical advice on improved forage species comes from research work conducted in other countries. It would be worthwhile to develop research that allows compiling information on the performance of these improved forage species in local environments and under actual climatic conditions in Puerto Rico.

#### **Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Objective 1. Best yield and quality in forages (grasses) was obtained with nitrogen applications between 250 and 300 pounds per acre per season.

Objective 2. Best soil preparation techniques, amount of seeds per acre and fertility recommendations have been developed from results obtained from research.

Objective 3. Best grasses varieties have been identified for different agroclimatic regions of Puerto Rico. Best performance was obtained for Megatyrus Maximus cv. Mombasa, Urochloa híbridos (cabello, cayman; for dry and humid zones respectively), and Urochloa decumbens cv. Basilisk for acid soils. Information has been useful to provide technical advice to farmers.

#### **Briefly describe how your target audience benefited from your project's activities.**

The results obtained from this research have been very useful to provide specialized technical advice to farmers. In the last three years more than 20 farmers have planted multiple acres of land with improved grasses. Most of the recommendations provided to them come from the results of this research. We have been able to recommend better fertilization practices, the amount of seed to use per acre for each variety, and most important, the specific variety to use for each soil and climatic region.

#### **Briefly describe how the broader public benefited from your project's activities.**

The information obtained will allow us to train farmers and agricultural agents, as well as develop publications with that purpose. In the long term, forage producers and farmers will have available reliable recommendations to withstand climatic change vulnerabilities.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

Two agricultural research technicians work in this project organizing all the duties and responsibilities. They take care of establishing, maintaining, and harvesting every research plot. For them this has been a great opportunity for professional development in the forage industry.

The information obtained from research has been mainly used to provide specialized technical advice to farmers when visiting farms. Fact sheets with the results per each variety will be published soon. We will be requesting a no-cost extension of time to be able to fulfill the goals of producing peer review publications, and outreach activities. The results will be used to develop two educational modules and a field training activity. All modules will be used to train farmers, agriculture agents, USDA NRCS personnel and other stakeholders.

- We will continue with the harvest of samples and analysis for quality in each location--Gurabo and Juana Diaz Puerto Rico-- for one more year. The extension on time, if provided, will be used to work on research publications, including conferences and seminars.

Data has not been published yet. Some fact sheets will be published in April 2023. After April 2023 conferences and seminars will be developed to train agricultural agents and farmers. At least one peer review paper will be published.

Activities- We are still conducting and analyzing data from the experiment to complete three years of data compilation.

Events- During February 2023 two conferences will be held to train farmers in concepts of forage production and fertility.

Services- Farmers will be provided with technical advice in the topics related to forage production when requested.

## **Characterization and relationships of growth patterns, eating behavior and health in slick and wild type- haired Puerto Rican Holstein calves and heifers**

Project Director

Hector Sanchez-Rodriguez

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1017581



### **Final Result-Characterization and relationships of growth patterns, eating behavior and health in slick and wild type- haired Puerto Rican Holstein calves and heifers**

Final Result

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

The past project (H-452) compared mature Holstein cows in terms of their hair coats (slick or wild type-haired) finding considerable advantages in slick-haired animals when exposed to heat stress. However, such comparison had not been done before in earlier stages of life. Thus, the H-496 project aimed to compare both hair coat types from birth to first parturition.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

The performed samplings allowed us to achieve the objectives originally established in the proposal. Slick and wild type-haired calves and heifers were compared in terms of growth, behavior and health. We are already working with the final dataset in order to write a manuscript and my graduate student Master's in Science thesis. The final results will provide useful information regarding any possible difference between both hair coat groups.

**Briefly describe how your target audience benefited from your project's activities.**

The target audience for project H-496 was the scientific community. In this regard, the results obtained under this project were presented at the 2019 Annual Meeting of the American Dairy Science Association (at Cincinnati, Ohio), the SOPCA 2019 43rd Annual Meeting (at San Juan, Puerto Rico), the Virtual 2020 Annual Meeting of the American Dairy Science Association, the Journal of Agriculture of the University of Puerto Rico, the 2021 Sigma Xi Poster Day (at Mayaguez, Puerto Rico), the 2021 ADSA Annual Meeting (at Louisville, Kentucky), (a second time) at the Journal of Agriculture of the University of Puerto Rico, and the SOPCA 2022 45th Annual Meeting at Coamo, Puerto Rico.

**Briefly describe how the broader public benefited from your project's activities.**

The scientific community and dairy farmers will benefit from the obtained results as this project has provided, and will provide, useful information about the comparison of slick and wild type-haired young cattle. As the available knowledge on this topic was limited to mature cows, the general public, scientists and producers will now have information on this animals regarding younger ages.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

- The project provided the opportunity for training and development of several graduate and multiple undergraduate students. Students were trained in the use of automatic dataloggers, cattle management and restriction, sampling, data processing and analysis, and scientific writing thanks to this project. This opportunity made them well-rounded students for their next steps in their academic lives, including graduate school.

The obtained results have been disseminated to the scientific community as Abstracts presented in several scientific meetings (the 2019 Annual Meeting of the American Dairy Science Association at Cincinnati, Ohio; the SOPCA 2019 43rd Annual Meeting at San Juan, Puerto Rico; the Virtual 2020 Annual Meeting of the American Dairy Science Association; the 2021 Sigma Xi Poster Day at Mayaguez, Puerto Rico; the 2021 ADSA Annual Meeting at Louisville, Kentucky; and the SOPCA 2022 45th Annual Meeting at Coamo, Puerto Rico). The results were also published as scientific articles at the Journal of Agriculture of the University of Puerto Rico. The final manuscripts and Master's Thesis will also help to further disseminate the obtained results.

- The project will be closed for the next report period.

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The following abstracts were published on 2022:

1) Héctor Sánchez, Carolina Domínguez, Anthony Muñiz, Tatiana Tosado, Zully Contreras, Katherine Domenech, and Gladycia Muñiz, 2022. Visual assessment for hair coat type classification in Puerto Rico slick and wild type-haired Holstein cows. Reunión Científica y Asamblea Anual SOPCA 2022. Centro de Convenciones de Coamo, Puerto Rico.

2) Ireliz Colón Rodríguez y Héctor L. Sánchez Rodríguez, 2022. Comparación y relación entre la temperatura rectal y tasa respiratoria durante las primeras 8 semanas de vida en becerras Holstein pelonas y de pelaje regular. Feria de Investigaciones UPRM 2022. 6 de abril de 2022.

: The project exposed multiple students (undergraduate and graduate) to scientific research, including data collection, management and analysis, as well as to scientific writing.

: On October 11, 2022 a symposia was performed for the Animal Science Department Students' Association, who were interested in the project. Also, results were presented at the SOPCA 2022 Annual Meeting and at the *Feria de Investigación* UPRM 2022.

: Multiple undergraduate (registered at the Special Topics class) and graduate students (as part of a Master's Thesis) were tutored during this project.

## Evaluation and selection of grain legumes genotypes with heat and drought tolerance in Puerto Rico

Project Director

Angela Linares-Ramirez

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1016323



### Final Result-Evaluation and selection of grain legumes genotypes with heat and drought tolerance in Puerto Rico

Final Result

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

The UPRM team evaluates and selects common bean (*Phaseolus vulgaris* L.) genotypes with greater heat and drought tolerance. Use of markers to identify genes/QTL associated with abiotic and biotic traits across *Phaseolus* genotypes. Investigate the effect of drought and heat using traditional cooking procedures on some important physicochemical and nutritional properties of common beans.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Overall the project has developed materials associated with the response to drought and heat tolerance that are an open source for nonprofits, public, and private among other organizations. The project has tested the performance of all major bean market classes under drought conditions in Puerto Rico and the effect on nutritional content and cooking time. Important genetic regions of interest also have been found. There is also information for the general public and farmers on the performance of several dry bean materials with the potential to grow in marginal areas of Puerto Rico.

**Briefly describe how your target audience benefited from your project's activities.**

The general public can know the limitations associated with climate change and food production due to the increase in temperature and variation with rainfall patterns in the Caribbean Basin and in Puerto Rico, specifically in the Lajas Valley.

**Briefly describe how the broader public benefited from your project's activities.**

With respect to climate change, agencies will know issues to mitigate, and issues to fund, what genetic material could be used, and strategies to increase the nutritional content. Also, will be able to know how Latin communities can benefit from studies that have been pursued over the last four years. Collaborations can also be in other crops that are facing similar issues due to climate change.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

**Training and professional development opportunities** - The project has provided opportunities to train students, mostly, on the evaluation of pollen viability, collecting data for agronomic and morphological traits in trials under normal conditions and trials under drought and high temperatures, and the identification and evaluation of diseases in common bean. In the last year of the project, a graduate student in food science had the opportunity to assist to the European Food Science Congress and present the results of her project in an oral presentation.

**Dissemination of results (outreach activities)** - Results have been disseminated in poster and oral sections, in formal professional meetings as well as in formal publications. Also, results have been disseminated through field days to students, extension service agents, crop insurance inspectors, and a poster presentation at the American Society of Agronomy/Crop Science Society of America annual meeting.

**Major changes or problems** - UPRM Strikes that prevented entry to laboratories and experimental stations. Also, climate variation in order to test for drought.

**Publications:**

Viteri, D.M., **A.M. Linares-Ramírez**, Z. Miranda and R. Vazquez. 2023. Registration of UPR-Mp- 34 and UPR-Mp-42 common bean germplasm with enhanced resistance to ashy stem blight. Journal of Plant Registrations. <https://doi.org/10.1002/plr2.20273>.

Vazquez, R., D.M., Viteri, **A. Linares-Ramírez**, and Z. Miranda. 2022. Reaction of Newly Developed Common Bean Germplasm to Natural Infections and Mechanical Inoculated of Two *Macrophomina phaseolina* Isolates. 44a Reunión Científica Anual de la Sociedad Puertorriqueña de Ciencias Agrícolas. Coamo, PR

Viteri, D.M., **A.M. Linares-Ramírez**, Z. Miranda and A. Shi. 2022. Identification of a QTL Region for Ashy Stem Blight Resistance Using Genome-wide Association and Linage Analysis in a Common Bean Recombinant Inbred Lines Derived from BAT 477 and NY6020-4. Frontiers in Plant Sciences. <https://doi.org/10.3389/fpls.2022.1019263>

Viteri, D and **Linares, A.** 2021. Agronomic performance of common and tepary bean genotypes and their response to ashy stem blight in Isabela and Lajas, Puerto Rico. Legume Science 4(2)e118.

**Other Products**- Germplasm has been deposited in USDA gene banks

**Plant Genetic Resources Conservation and Utilization**

Project Director

Carlos Flores

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1017544



**Plant Genetic Resources Conservation and Utilization**

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**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

: This project focuses on the evaluation of accessions of climbing vine fruit crops, of *Passiflora edulis*, *Passiflora quadrangularis* and *Sicana odorata*. Passionfruit is an economically important tropical crop, currently undergoing a revival in Puerto Rico and the southern US. Appropriate genotypes and planting material are key for good yield and quality, yet at present growers in Puerto Rico, Florida and other locations are using seeds of unknown varieties or segregating progenies of open pollination plants of *Passiflora edulis* (passionfruit) and other climbing vine crops such as *Passiflora quadrangularis* (giant granadilla) and *Sicana odorata* (Brazilian melon). This project aims at selecting and evaluating genotypes of *Passiflora* and *Sicana* in the conditions of Puerto Rico.

: The future perspectives for plantain and banana production require extensive research of potential varieties capable of facing climate change and with tolerance to their most limiting pests and diseases. A collection of varieties with a broad genetic diversity guarantees the success of food security, family farming and agriculture for the next generations. The agronomic and IPM practices evaluation of these varieties will allow us to bring tools to the producers to be prepared for future outbreaks and hurricane seasons. Currently, the farmers are importing tissue culture plantlets as seeds for the next planting seasons or buying them internally from other farmers. Due to the presence of banana wilt (FocTR4) disease in Colombia, farmers need to implement biosecurity standards on their farms and one of the first lines of safety is the source of seed or disease-free propagation material.

: The root crops represent after plantain and banana, the primary source of energy in the Caribbean and Puerto Rico. All the root crops depend on vegetative seed for their production, and farmers lack good practices for seed multiplication that ensure them a more marketable crop. Currently, in Puerto Rico only 20 to 10% of these root crops local demand is produced locally.

Coffee (*Coffea arabica* L.) varieties “Limani” and “Fronton”, have rust (*Hemileia vastatrix*) tolerance and superior organoleptic characteristics than the traditional commercial varieties. Due to a recent DNA research performed in 2021, the AES has a genetic database of the 36 original accessions conserved in the coffee collection as coffee rust-resistant material. Two of those accessions identified as Limani have four (4) unique genotypes and Fronton has one (1) unique genotype with different genetically stable promising rust resistant characteristics that are currently under study.

: Milk and meat production represent over 25% of its gross domestic income and rely on grasses and legumes that include a variety of native, naturalized and improved herbaceous and woody plants. Continued research on newly introduced grasses and legume germplasm in the different agro-ecosystems (wet and dry seasons) are key to mitigating climate change such as restoration of degraded pasturelands, carbon sequestration, and reduction of greenhouse gas emissions.

: The Agricultural Experiment Station (AES) of the University of Puerto Rico, Mayagüez, is working with citrus plant production systems and different citrus varieties to determine which varieties and scions are more productive under different climate scenarios and pest infections (i.e., Citrus greening and Tristeza). We could execute this by evaluating a big bank of material gathered from the USA and acclimatizing and preserving in our free-pest germplasm structures.

The necrotrophic fungus *Macrophomina phaseolina* is an important pathogen in legumes and other crops worldwide. Genetic resistance is the most efficient technique to manage this pathogen. Currently, cultivars of common bean in Puerto Rico are susceptible to this fungus. Thus, we developed a new germplasm namely UPR-Mp-23, UPR-Mp-34, UPR-Mp-42, and UPR-Mp-48 with improved resistance that can be used in common bean breeding programs. Furthermore, three QTL on chromosomes 3, 7, 9 were identified to confer resistance to *M. phaseolina*. Regarding pigeonpea breeding, a new pigeonpea cultivar namely ‘Isabella’ with higher yield and early maturity was released.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

: Field experiments were conducted in Lajas and Isabela, Puerto Rico, to evaluate the field performance and fruit yield and quality of passionfruit, giant granadilla and Brazilian melon. The results of said experiments served as screening indicators to rank the genotypes evaluated in terms of their fruit productivity and fruit quality. Also, an online survey was conducted through the Agricultural Extension Service of the UPR-Mayaguez to determine the situation and needs of growers of passionfruit in Puerto Rico.

: The agronomic evaluation and desirable characteristics of the banana FHIA02 (Monalisa) allow us to recommend it as a desirable alternative variety for organic production since its performance without nematicide or chemical fungicides was as good or better as the one with those applications. This evaluation was presented as part of the requirement for graduation of the Master student Elvin Lassalle, on Crop Protection during last semester. The thesis is available at the repository library and presented at the annual meeting of SOPCA 2022. Technical notes will be published in 2023 to promote its production among organic farmers. Integrated Pest and disease Management practices are under evaluation for the protection of our banana and plantain production against limiting diseases such as Fusarium Tropical Race 4 and Moko not yet at the Island. Biosecurity talks about the risk of the entry of these diseases had been part of the awareness of the public and producers.

: This project aims to provide the farmer’s decontamination and multiplication methods for the propagation material or vegetative seed of root crops like sweet potato, yam, taro, tanager, white carrot (apio) and cassava. In addition, provide the latest information of alternative varieties and their production of sweet potato, white carrot, and cassava.

: This project focuses on the phenological evaluation of five existing coffee accessions, with unique stable genotype recently discovered by DNA research and its promising rust resistant characteristics. Organoleptic traits must be described before release and recommend its commercial use.

Liquid urea (LU) provided an excellent source of N, especially in the NH<sub>4</sub><sup>+</sup> form required by the grass Mombasa. This research showed the LU application rate of 100 lbs./acre is an alternative to enhance Mombasa production in Puerto Rico through synchronized 35-d harvests. In addition, Cowpea lines were found to have multiple usage (hay and cover crop), the potential for seed increase of an annual soybean (photoinsensitive) is possible during the short-days (October-December).

: We have established two experimental fields in two distinct locations with different objectives. In Isabela-AES, we are evaluating three cultivars (Mexican lime, fine clementine mandarin, and Campbell Valencia orange) grafted in three rootstocks (HRS 897, HRS 812, and Swingle). In Corozal-AES, we are evaluating 812 under three planting distances (5.5 m by 2.4 m, 5.5 m by 3.05 m, and 5.5 m by 3.66 m). In each location, is collected soil and tissue samples. Also, tree parameters (height and shoot diameter) and yield (fruit quantity and quality) data are collected. In the Isabela-AES location, we also collect citrus greening and UAV data (tree canopy). Gathered Isabela data was published in Horticulturae Journal-MDPI on June 11th, 2022. The Manuscript title is Early Response of 'Mexican' Lime, 'Fina' Clementine Mandarin, and 'Campbell' Valencia Orange on Selected Rootstocks Grown under Fertigation Practices in an Oxisol in Puerto Rico. Regarding the data collected from the Corozal-AES location, we are analyzing and writing a manuscript entitled: Effect of crop distance in 'Pera' sweet orange grafted in 'HRS 812' Rootstock in Corozal Puerto Rico which will be submitted to The Journal of Agriculture of the University of Puerto Rico no later than March 2023.

In addition, assessments are secure in protected screen greenhouses in Adjuntas, Corozal, and Isabela- AES. In addition, we have rootstock collections in the field from which we collect rootstock seeds (Isabela and Corozal).

The UPR-Mp common bean breeding were inoculated with the PRI21 *M. phaseolina* isolate in the field and greenhouse. These lines had intermediate response to this fungus in two locations (i.e., Isabela and Lajas) and can be used to increase the levels of resistance of common bean cultivars. Also, genome wide association analysis allowed the identification of novel QTL derived from BAT 477, 'PC 50', and PRA154 common bean genotypes. These QTL can also be used in common bean breeding programs. 'Isabella' is an early maturity (110-130 days to harvesting) and had higher seed-yield (647- 4,300 kg/ha) compared to 'Lazaro' (128-149 days and 619-3,700 kg/ha) in seed-yield trials conducted in Isabela and Lajas in 2021 and 2022.

### **Briefly describe how your target audience benefited from your project's activities.**

: Due to the research conducted in this project, we now have more information about which genotypes may be better choices for growers.

: Banana and plantain farmers, producers, and researchers, interested on varieties with desirable characteristics in Puerto Rico will have an alternative variety to produce at the mountain region organic banana, with less production costs and no chemical applications. Field days to transfer new protocols for decontamination and treatment of propagation material (vegetative seed), multiplication of planting material, integrated plant-pathogens and pest management and production has been given to agricultural department Agronomists, extension agents and local farmers.

: Root crops farmers will be able to apply easy practices for the decontamination and multiplication of their vegetative seed that ensure a better quality of their crops that allows them to occupy a fair space in the local market. Provide an alternative to produce their own propagation material in their own farms with their best material, avoid their exchange and the entry of devastating diseases. The farmers will have alternative varieties with potential new marketable areas. Recommendations after evaluation of these varieties and practices will be published and demonstrated to Agricultural Extension Agents, farmers, and students.

: The farmers will have other alternative varieties resistant to rust as a strategy to continue growing coffee without pesticides. This reduces production costs, environmental risks and increases the quality of the product.

: Research results on Mombasa were presented to stakeholders and Agricultural Extension Personnel individually, increasing planting of grass Mombasa occurred in the North- and South-western regions of Puerto Rico.

: The following audience (Undergraduate and graduate students in Agronomy, Horticulture, Soils, and Crop Protection, Farmers in Puerto Rico and other tropical/subtropical locations, Extension personnel who provide technical assistance to farmers, Department of Agriculture of Puerto Rico, and others) can use our results for personal benefit or for to provide guidance to other people in the citrus industry or interested in citrus. Also, this audience can be able to buy pest-free certified citrus trees at Isabela and Adjuntas-AES or can buy seeds of recommended rootstocks such as HRS-812, Swingle, and Carrizo. Part of the citrus material used for those certified trees comes from assessments secured in the protected greenhouse, and all the citrus seeds come from field rootstock collections.

: Targeted audiences include: Pigeonpea growers in Puerto Rico and the Caribbean Basin needing cultivars with early maturity and higher agronomic performance. Extension personnel in Puerto Rico who provide technical assistance to legume growers. Plant Breeders who need new common bean and pigeonpea germplasm with resistance to ashy stem blight and insensitive to the photoperiod, respectively.

### **Briefly describe how the broader public benefited from your project's activities.**

: Production of fruits with genotypes developed and evaluated locally benefits growers and fruit consumers, in terms of fruit freshness, support of local producers, reduced cost of transportation and storage and their environmental impact.

: The broader public may benefit from having more diverse and healthy produce on the market, ensuring its food security.



: Consumers and farmers will have access to varieties produced with fewer applications of pesticides, and with higher nutritional properties. Furthermore, researchers and students will have access to a catalog for each root crop of the varieties available for further evaluations or research.

Consumers and farmers will have the benefit of a coffee crop free of pesticides and at lower cost.

: In November 2021, there was a formal presentation to the Puerto Rican Society of Agricultural Sciences (SOPCA) to discuss preliminary results on new Urochloa grass cultivars. At this meeting, scientists, graduate students, extension personnel and stakeholders participated. In addition, a poster was presented at the American Society of Agronomy to a national and international audience.

: The broader public continues buying pest-free certified citrus trees at Isabela and Adjuntas-AES and/or buying seeds of recommended rootstocks such as HRS-812, Swingle, and Carrizo.

The new legume cultivars will be a source of food. Also, the new germplasm with improved resistance to *M. phaseolina* can be used to improve the resistance of common bean cultivars of different market classes in the future. With this, the application of fungicides will be decreased or eliminated contributing to sustainable agriculture.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

: Undergraduate students, Nahomi Martinez, Stephanie Sepulveda and Rigo Espiña had the opportunity of training in production of clean and certified vegetative seed of white carrot under laboratory (tissue culture) and sweet potato at the greenhouse conditions under the supervision of Dra. Martha Giraldo at the Phytopathology and Tissue Culture Laboratory during summer 2022. Two graduate students were funded under this project for a Master of Science degree in Agronomy. In December 2021 Carolyn Castillo defended her thesis “Liquid urea rate effects on yield and nutritional value of tropical pastures” and in May 2022, Maria Montas defended her thesis research “Agronomic characterization, bromatology and cultivar management of Urochloa in Puerto Rico”.

Results were presented and disseminated to the scientific community in annual meetings such as the National Association of Plant Breeders and the American Phytopathological Society; Puerto Rico Agriculture Science Society (SOPCA), International Society for Horticultural Science, International Symposium on Pomegranate and Minor Mediterranean Fruits, First Seed Festival at Juana Diaz Agricultural Experiment Station, American Society of Agronomy in Phoenix, Arizona and to growers, students, and public by the local newspaper, interactive talks and local meetings.

:

Morales-Payan, J. P. 2021. Evaluation of giant granadilla accessions in a pergola system. *Acta Horticulturae* 1345:431-434.

Morales-Payan, J.P. (2022). Comparison of fruit yield, vine growth, and damage from *Dione juno* in three cloned passion fruit accessions. *Acta Horticulturae* 1349:19-22.

Morales-Payan, J. P. 2022. Yellow passion fruit conservation for the fresh market as affected by postharvest wax and cytokinin treatments. *Acta Horticulturae* 1344: 245-248.

Lassalle Loperena, E. A. (2022). Evaluación del híbrido de banano FHIA-02, Musa AAAA Mona Lisa, en respuesta a nematodos fitoparásitos en Puerto Rico [Thesis]. Retrieved from <https://hdl.handle.net/20.500.11801/2884>

Giraldo Zapata, M. C., Cortés, M., Chávez-Jáuregui, R. N., Ortiz, C. E., Alicea, C. M., Díaz, M., Matos, D. (2022). Conjunto Tecnológico para la Producción de Apio [Technical Report]. Agricultural Experiment Station. Retrieved from <https://hdl.handle.net/20.500.11801/2873>

Giraldo Zapata, M. C. (2022). Catálogo de variedades de apio Arracacia xanthorrhiza en Puerto Rico [Technical Report]. Agricultural Experiment Station. Retrieved from <https://hdl.handle.net/20.500.11801/2871>

Giraldo, M. C., Almodóvar, W., Soto-Torres, G., Macchiavelli-Girón, S., & Martínez-Cales, E. (2022). Plan de manejo integrado para el control del piche de la batata [Technical Report]. Agricultural Experiment Station. Retrieved from <https://hdl.handle.net/20.500.11801/2888>

Giraldo, M. C., Almodóvar, W., & Martínez-Cales, E. (2022). El piche de la batata *Cylas formicarius*. [Technical Report]. Agricultural Experiment Station.

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Viteri, D. M., Linares, A. M., Zoralys, A. M., and Vázquez, R. (2023). Registration of UPR-Mp-34 and UPR-Mp-42 common bean germplasm with enhanced resistance to ashy stem blight. *Journal of Plant Registrations*: In Press. <https://doi.org/10.1002/plr2.20273>

Viteri, D. M., & Linares, A. M. (2022). Screening a newly developed common bean germplasm with improved resistance to ashy stem blight in multiple environments. *Frontiers in Plant Science*, Vol 13: 1052398. <https://doi.org/10.3389/fpls.2022.1052398>

Viteri, D. M., Linares, A. M., Zoralys, A. M., and Shi, A. (2022). Identification of a QTL region for ashy stem blight resistance using genome wide association and lineage analysis in common bean recombinant inbred lines derived from BAT 477 and NY6020-4. *Frontiers in Plant Science*, Vol 13: 1019263. <https://doi.org/10.3389/fpls.2022.1019263>

Viteri, D. M., & Linares, A. M. (2022). Agronomic performance of common and tepary bean genotypes and their response to ashy stem blight in Isabela and Lajas, Puerto Rico. *Legume Science*, Vol. 4 (2): e118. <https://doi.org/10.1002/leg3.118>

Sarmiento, L., Viteri, D. M., Linares, A. M., & González, K. (2021). Evaluación agronómica de 15 genotipos de gandul [*Cajanus cajan* (L.) Millsp.], en Isabela y Lajas, Puerto Rico. *The Journal of Agriculture of the University of Puerto Rico*, Vol. 105 (2): 179–202. <https://doi.org/10.46429/jaupr.v105i2.20079>

## **Control of *Helicoverpa* spp. and *Spodoptera* spp. pests in pigeon pea and sweet corn by the use of biological agents alone and in combination with low-toxic synthetic insecticides**

Project Director

DIEGO VITERI

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1012972

### **Final Result-Control of *Helicoverpa* spp. and *Spodoptera* spp. pests in pigeon pea and sweet corn by the use of biological agents alone and in combination with low-toxic synthet**

Final Result

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Lepidoptera species are the major pests in pigeon pea [*Cajanus cajan* (L.) Mill.] and sweet corn (*Zea mays* L.) in Puerto Rico and tropical environments worldwide. Larvae attack all plant stages and yield losses can reach 100% if control measures are not applied on time. Resistance to conventional insecticides and *Bacillus thuringiensis* have been reported for *Helicoverpa* spp. and *Spodoptera* spp. Thus, alternative strategies of control by the use of biological agents alone and in combination with low toxic synthetic insecticides need to be evaluated.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Tobacco budworm, *Heliothis virescens*, was identified affecting flowers, pods and seeds of pigeonpea. Fall armyworm, *Spodoptera frugiperda*, was observed in all plant stages, whereas corn earworm, *Helicoverpa zea*, and the sugarcane borer, *Diatraea saccharalis*, affected only ears in sweet corn. This information is valuable to establish an adequate insecticide rotation to control these Lepidoptera species for each crop.

Larvae of corn earworm and fall armyworm were susceptible (mortality > 80% at 96 h) to *Steinernema carpocapsae* + oil and to methomyl, respectively, whereas both species were susceptible to chlorpyrifos. Likewise, the use of emamectin benzoate, *S. carpocapsae* + chlorantraniliprole or spinetoram caused fall armyworm larval mortality of over 70% at 72 h at the high dose. The LC50 values for chlorpyrifos was 248 ppm, whereas 312,500 *S. carpocapsae* nematodes per L + 625 ppm of rapeseed oil caused 53% of larval mortality at 120 h post-treatment for corn earworm larvae. Conversely, the LC50 value was 2,754 ppm for chlorantraniliprole and 851 ppm for spinetoram at 96 h for fall armyworm larvae. Also, chlorantraniliprole and spinetoram caused weight reduction in corn earworm and fall armyworm larvae treated with these active ingredients. The combinations of *S. carpocapsae* with conventional insecticides should be used in rotations with chlorpyrifos, emamectin benzoate, chlorantraniliprole, and spinetoram to control fall armyworm and corn earworm larvae in the field.

The use of low dosages of chlorantraniliprole + nucleopolyhedrovirus and chlorantraniliprole + SC + oil increased significantly dry-pod (2.18 and 2.20 t/ha) and seed-yield (1.27 and 1.23 t/ha); while high dosages of  $\beta$ -cyfluthrin and chlorantraniliprole increased yield significantly (2.04 and 2.44; 1.72 and 1.69 t/ha) compared to the control (1.25 and 0.76 for dry-pod; and 0.78 and 0.26 t/ha for seed in 2017 and 2018, respectively) in pigeonpea. In contrast, applications of high dosages of emamectin benzoate and chlorantraniliprole at 48 h after pollination, increased the number of kernels (281-294) and reduced the damage of larvae on kernels (<0.5%) compared to the control (201-229; >7%). These informations should be used by entomologists and plant breeders to schedule the insecticide applications in the field.

**Briefly describe how your target audience benefited from your project's activities.**

These results will be of benefit to Entomology scientists who need to know the levels of resistance of Lepidoptera species to different active ingredients. Also to the seed industry and to private companies that have more than 2,000 acres of corn, soybean, tomato, sorghum, and other vegetables that are attacked by fall armyworm, corn earworm, and/or tobacco budworm larvae every year.

**Briefly describe how the broader public benefited from your project's activities.**

Students who work in practical training in this topic (e.g., collecting larvae, bio-assays, and efficacy trials to insecticides in the field) also benefited from this project's activities.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

- Participation in the Annual meeting of the Entomology and Agriculture in Australia, Brazil, Puerto Rico, United Kingdom, and United States. Also, by a workshop and field training conducted in Research Substations at the University of Puerto Rico.

) - By the scientific meetings and workshops mentioned above.

- This is a final report. One more scientific manuscript will be published. Also, final data of bioassays studies will be presented at the annual meeting of the Entomological Society of America (Southeastern Branch) on March, 2022.

- Due to the COVID 19 pandemic bioassays trials and field experiments were delayed. A 6 months extension was requested to complete one of the objectives in this project.

: (Journal Articles):

Viteri, D., and Linares, A. 2022. Timely application of four insecticides to control corn earworm and fall armyworm larvae in sweet corn. Insects.

Sarmiento, L., Viteri, D., Linares, A., and Cabrera, I. 2022. Bio-ensayos de insecticidas biológicos y orgánicos sintéticos en larvas del gusano de la mazorca del maíz [*Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae)]. Journal of Agriculture of the University of Puerto Rico.

Viteri, D., Sarmiento, L., Linares, A., and Cabrera, I. 2019. Efficacy of biological control agents, synthetic insecticides, and their combinations to control tobacco budworm [*Heliothis virescens* (Lepidoptera: Noctuidae)] in pigeonpea. Crop Protection 122:175-179.

Viteri, D., Linares, A., Cabrera, I., and Sarmiento, L. 2019. Presence of corn earworm and fall armyworm (Lepidoptera: Noctuidae) populations in sweet corn and their susceptibility to insecticides in Puerto Rico. Florida Entomologist 102 (2):451-454.

Viteri, D., Linares, A., and Flores, L. 2018. Use of the entomopathogenic nematode *Steinernema carpocapsae* in combination with low-toxicity insecticides to control fall armyworm (Lepidoptera: Noctuidae) larvae. Florida Entomologist 101 (2):327-329.

Protocols: Bioassays protocols to evaluate insecticide resistance for corn earworm and fall armyworm. Protocol to conduct insecticide sprays in sweet corn at reproductive stages.

## Fertilizers and Phytostimulators for field and postharvest performance of pomegranate, breadfruit, and avocado

Project Director

Jose Morales-Payan

Organization

University of Puerto Rico Mayaguez Campus

Accession Number

1013223



### Final Result-Fertilizers and Phytostimulators for field and postharvest performance of pomegranate, breadfruit, and avocado

Final Result

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Avocado fertilization in Puerto Rico is largely based on information borrowed from fertilization of other tree crops in the island, anecdotes provided by growers in the island (rarely based in controlled experiments), and information on fertilization of avocado elsewhere. There is no known research conducted in Puerto Rico for fertilizers on breadfruit and pomegranate. Nor there is information based on research about the effects of phytostimulators on the efficiency or need for fertilizers in those crops.

This project aims at developing information on the combined effects of fertilization and phytostimulators on growth, pest, diseases, yield, quality and postharvest life of pomegranate, avocado, and breadfruit grown in Puerto Rico.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Avocado: The research was done with the 'Butler' avocado, which is the main commercial variety in Puerto Rico. The project evaluated the effects of 12 regimens of nitrogen (N) fertilization, including N application during flower induction, flowering, and early and late fruit growth. Fruit yield was significantly influenced by N treatments, due mainly to changes in fruit number rather than to individual fruit weight. Yield was greater when 800 or 900 g N were distributed in three equal applications at flower induction, flowering and fruit development, while N application at only 2 or those 3 stages resulted in lower yield. Those results may be instrumental in developing better N management practices for 'Butler' avocado.

Breadfruit: We studied the effects of two rates of N (typical rate and 1.25 the typical rate) and soil-applied phytostimulants on breadfruit growth and fruit yield. The higher N rate resulted in larger trees with greener leaves and greater fruit yield. The phytostimulants were a 6% amino acid blend (3 L/ha/year), a 5.5% peptide mixture (2.5 L/ha/year), a 4% humic acid formulation (7 L/ha/year), and an alga extract with the equivalent of 100 g per L of kinetin (3 L/ha/year). Trees were larger and produced more fruit when treated with the peptide formulation than when treated with the amino acid or the alga extract formulations. Trees without biostimulant application had the lowest fruit yield. These results indicate that tree size and fruit yield can be managed with N and phytostimulant applications.

Pomegranate: The treatments were the same as in breadfruit, but the results were different. Extra N did not benefit pomegranate. Application of the alga extract and the peptide formulations resulted in more productive plants, and application of the amino acid phytostimulant were less damaged by the *Pseudocercospora punicae* leaf spot. These results indicate that in the tropical conditions of Puerto Rico, pomegranate growth and yield may be regulated using phytostimulants, but not with greater rates of N.

**Briefly describe how your target audience benefited from your project's activities.**

This information may help growers and other stakeholders decide which practices are a good fit to their interests and may help reduce wasteful and

potentially polluting use of fertilizers in those crops.

**Briefly describe how the broader public benefited from your project's activities.**

Throughout the duration of the project, graduate and undergraduate students of agricultural sciences from the UPR Mayaguez Campus were informed and trained in practices of pomegranate, avocado, and breadfruit management, including planting, fertilization, irrigation, crop protection, pest and disease monitoring, harvesting, and evaluation of physical and chemical fruit quality. Two graduate students in the MS program of Horticulture at UPR-Mayaguez conducted their research in the orchards of the project. Also, growers and extension agents were exposed to the project. While avocado is a common fruit tree crop in Puerto Rico, both pomegranate and breadfruit are relatively new as crops in the island (although known in Puerto Rico for several centuries). Therefore, this research and the training of human resources associated with it is likely to have a deep impact on the increase of knowledge about those crops in the stakeholders exposed to the project.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

- Throughout the duration of the project, graduate and undergraduate students of agricultural sciences from the UPR Mayaguez Campus were informed and trained in practices of pomegranate, avocado, and breadfruit management, including planting, fertilization, irrigation, crop protection, pest and disease monitoring, harvesting, and evaluation of physical and chemical fruit quality. Two graduate students in the MS program of Horticulture at UPR-Mayaguez conducted their research in the orchards of the project. Also, growers and extension agents were exposed to the project. While avocado is a common fruit tree crop in Puerto Rico, both pomegranate and breadfruit are relatively new as crops in the island (although known in Puerto Rico for several centuries). Therefore, this research and the training of human resources associated with it is likely to have a deep impact on the increase of knowledge about those crops in the stakeholders exposed to the project.

) - The results have been disseminated mainly through visits to the orchards, information shared in formal teaching and extension, as well as presentations and publications.

-The COVID19 pandemic limited the training and outreach activities in part of 2020 and 2021. Nevertheless, when in-person activities were not possible, dissemination of the activities and results of the project were conducted Online.

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Morales-Payan, J. P. 2022. Biostimulants and nitrogen affect pomegranate flowering and fruiting. I International Symposium of Reproductive Biology of Fruit Tree Species. Acta Horticulturae.

Morales-Payan, J. P. 2021. Flower and fruit production of 'Wilson' avocado in response to paclobutrazol. I International Symposium of Reproductive Biology of Fruit Tree Species. (France, online) Book of Abstracts, page 32.

Morales-Payan, J. P. 2022. Managing breadfruit yield with soil-applied nitrogen and biostimulants. IX International Symposium on Mineral Nutrition of Fruit Crops. Acta Horticulturae.

Morales-Payan, J. P. 2021. Avocado tree growth and fruit yield in response to nitrogen fertilization regimens. Acta Horticulturae.

Morales-Payan, J. P. 2021. Breadfruit Response to Nitrogen and Biostimulants. The Northeastern Plant, Pest, and Soil Conference. January 4-7, 2021. Abstract 30.

Morales-Payan, J. P. 2021. Efectos de bioestimulantes y nitrógeno en árboles juveniles de *Artocarpus altilis*. Abstract Book, page 82. Online Congress of Citrus, Olive and Fruits. Spanish Society for Horticultural Sciences. March 23-25, 2021.

Morales-Payan, J. P. 2021. Effect of Selected Biostimulants on Pomegranate Growth. The Northeastern Plant, Pest, and Soil Conference. January 4-7, 2021. Abstract 29.

Morales-Payan, J. P. 2021. Breadfruit Response to Nitrogen and Biostimulants. The Northeastern Plant, Pest, and Soil Conference. January 4-7, 2021. Abstract 30.

Morales-Payan, J. P. 2021. Avocado as Affected by Nitrogen Application Programs. The Northeastern Plant, Pest, and Soil Conference. January 4-7, 2021. Abstract 31.

Teaching: Students of agricultural sciences from the UPR Mayaguez Campus were informed of the project, its materials and methods, and its results. This was done in study tours (formal teaching), and as volunteers participating in the project activities.

Training: Students of agricultural sciences from UPR Mayaguez Campus were trained in orchard maintenance practices, fruit harvesting, assessment of fruit quality, and the scientific method. Also, growers and extension agents were exposed to the project.

Graduate students: Two MS students in Horticulture conducted their research in the project, and were trained in research methods and fruit crop management.

Critical Issue

## Positive youth development

### Teens leading the change for community wellness.

Project Director

Jaime Curbelo

Organization

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Accession Number

7004666



### 4-H: an inclusive space that provides opportunities for children and youth

**In 2-3 sentences, briefly describe the issue or problem that your project addresses.**

Prior to the pandemic, youth of Puerto Rico were struggling with challenges related to poverty environments. Moreover, the pandemic dramatically impacted youth's mental health and academic performance. The lack of educational opportunities and access to health services and food, mainly due to the closing of schools, exacerbated our youth precarious situation. The lag and dropout rate increased during this period, so it is required that the education system and organizations like Extension establish alliances that support and advocate for more educational opportunities for young people (no one is left out). It is vital that our youth get the tools and the encouragement to complete high school, prepare and motivate them to undertake the actions of social justice and economic development of the country.

**Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.**

Our major activities incorporated interdisciplinary initiatives that integrated 4H members' needs and program objectives at the local, regional, and state level:

The Bee Team (an online and person to person initiative) connected our children and youth with apiculture as an agriculture field that provided scientific knowledge, careers opportunities and entrepreneur alternatives.

The "Ruta 4-H para una vida saludable" initiative, through school and community teen teaching, provided train the trainer activities to 4H members about healthy living lifestyles and production of food at home and schools.

The initiative ACCESO served as a space to reflect and work about inequities that predispose people to homelessness; a situation that has increased in youth and college students in the last decade. Educational activities focused on positive youth development and developing critical thinking and create spaces to analyze how inequities and exclusions impact youth and society.

The initiative "4-H Pintado para otros" instructed our 4H youth about social responsibility through home improvements and interior design principles.

The “Explora” initiative provided to our participants exposition to different professionals to identify their career goals. It was a hybrid educational program that included virtual rooms, shadowing experiences and field trips to universities around the island. Eighteen (18) professionals (chemical, microbiologist, pediatrician, veterinary professors among other resources) offered volunteer work to complete the program. Fifty-six (56) youth benefited from this initiative and 4 Extension Educators designed the initiative and offered mentorship to the participants.

The OYE initiative, educated our 4-H program in an inclusive place for deaf and blind youth, sum two more initiatives: Oye Filmmaking Team and Oye ...Kids, teens and more. We received funding for both initiatives to develop community action plans and provide scholarships for 5 youth leaders. Forty participants benefited from these initiatives, 5 youth leaders designed and offered workshops, and 7 youth leaders were certified in American Sign language (basic and intermediate level) Camps, forums, virtual opportunities, workshops, field experiences, 4-H week and state conferences were some additional activities in which youth improved their teaching and leadership skills, teamwork strategies and communications abilities. All the activities included advocacy, emergency preparedness, diseases prevention and other approaches like 4-H DEI objectives and SDGs, that provided knowledge and experiences connected to youth to daily life's realities.

**Briefly describe how your target audience benefited from your project's activities.**

Our healthy habits initiatives, sponsored by the National 4-H Council and Walmart foundation, celebrated 12 years promoting healthy lifestyles with youth in the island.

At the Healthy Living Summit PR our 4-H Ambassador presented an action plan to work with homeless people. The plan was approved, giving birth to ACCESO (access), a project for 4-H teen leaders to learn about how to appropriately serve the homelessness community. Through this program they also acquired knowledge to identify risk factors associated with increased predisposition to become homeless.

A total of 1,294 participants completed non-formal education in healthy lifestyles.

Thirty-five (35) youth leaders were trained to broaden the educational reach of healthy lifestyles.

Five youth leaders represented Puerto Rico at the Healthy Living Summit 2022.

The initiative benefited more than 75 homeless people, by receiving articles and food collected in 4-H DropBOX stations.

4-H Youth leader (6) provided workshops about general hygiene and hand washing and offered time to organized food storage at homelessness center.

Youth and adults (52) obtained the opportunity to interact with an expert panel in the area and working with governmental processes and non-profit organizations.

Kids and youth learned about related professional careers in entomology and the role of insects in food production, environmental diversity, and their impact in reducing world hunger.

Two young participants demonstrated interest in pursuing an entomology career after participating in the bug camp. One of them was accepted to begin study in College of Agricultural Sciences in august 2023. This participant is 4-H spokesperson in entomology area.

Fifteen participants completed camp activities and five extension educators served as mentors. This Camp had a holistic professional team (entomology specialist, agronomist and family and consumer science educator).



With the Ag Challenge initiative (Reto Agrícola 4-H) a total of 15 4-H participants completed 45 hours of education and practices related to apiculture. These 4Hs participants were the first group of youth to be certified as apiculture apprentices.

Five participants served as peer educators in Pollinators Fairs and in school activities.

One of the 4-H youth participated in the Agri-Innovation Week invited by Corteva Agriscience sponsor. The 4H participant was certified in entrepreneurship practices to promote youth business initiatives.

Fifty-six (56) 4-H participants between 12 and 18 years explored career opportunities and strategies better to face the challenges related to college life.

**Briefly describe how the broader public benefited from your project's activities.**

Since the objectives of the programs involve the creation of safe learning spaces that promote opportunities and experiences for children and youth, every single achievement obtained will benefit the public in general.

**Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.**

Youth experienced virtual burnout, but we maintain communication with teen leaders to create and innovate 4-H strategies. New opportunities to work are civic responsibility projects, careers exploration, urban forestation, agriculture entrepreneur. In addition, the “Fondita de Jesus” (nonprofit organization) committed with us to create a youth and adult academy to work with homeless initiatives.

Type

**Projects / Programs without a Critical Issue**

**Not Provided**

Projects / Programs

**0**