# Puerto Rico (University of Puerto Rico Mayaguez Campus) Annual Report - FY2024

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## Contributing Organizations

University of Puerto Rico Mayaguez Campus

## Executive Summary

**Overview**

This annual report presents the most salient research and educational achievements by the University of Puerto Rico's Agricultural Experiment Station (PRAEXS) and Agricultural Extension Service (PRAES) during FY2023–2024, aligned with the six Critical Issues of the 2024–2029 approved POW:

1. Food Security, Plants and Animal Systems
2. Extreme Weather, Natural Resources, 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 remains central in Puerto Rico, where weather extremes, economic instability, and natural disasters pose serious threats to agricultural sustainability. Resilient plant and animal systems are essential for reliable food access, supporting rural communities, and preserving cultural and ecological heritage. Therefore, Food Security, Plants and Animal Systems continue to be critical for both PRAES and PRAEXS. More than 60% of our research projects are contributing to this issue's progress and despite challenges, such as recurring climate events, most projects were able to adjust their work schedules and fulfill the objectives planned for the year. Collaborations between both units continue to leverage progress and many of the achievements made in this and other shared critical issues.

Shifting from conventional to sustainable agriculture has equipped farmers with climate-smart methods to enhance productivity, reduce input costs, and protect the environment. These practices are key to withstanding shifting weather and scarce natural resources.

In plant systems, tissue culture technology in plantain production has empowered farmers to adopt sustainable practices such as organic farming, integrated pest management, and precision fertilization. Research on crop varieties and weed control adapted to organic or agroecological systems has yielded effective recommendations, contributing to local food security while supporting environmental sustainability.

Improving local crop varieties—such as new pigeon pea cultivars—remains vital for food security. Root crops like sweet potatoes and yams, long staples in Puerto Rico, have suffered production declines and post-harvest losses. Research identified the reniform nematode as a key contributor to sweet potato decline. The production of disease-free yam seeds using a Temporary Immersion Bioreactor should help prevent diseases related to high nematode populations. In collaboration with PRAES, selected yam farmers have received quality seeds and training in disease and postharvest management practices.

Community-driven innovation is strengthening food systems through traditional and modern practices. The conservation of Criollo cattle, a hardy breed introduced in 1505, reflects this approach. Research, training, and population monitoring efforts to preserve the breed not only preserve genetic diversity but also sustain rural livelihoods and historical practices.

Progress in animal systems includes research comparing slick-haired and wild-type Holsteins for traits like thermoregulation, reproduction, feed efficiency, and productivity. Soil fertility recommendations for forage production have improved, and beef cattle experiments using Red Angus x Senepol crosses showed promising gains: crossbred cows weaned calves averaging 20.4 lb more per cow, potentially increasing profit by $28.53 at current market rate of $1.40/lb live weight for weaned calves. Genomic studies on slick-haired and Criollo cattle are advancing and support PRAES efforts. Research also provided small ruminant producers with findings to improve their operations.

Pollinator decline after Hurricane María prompted the launch of the Honeybee Research and Extension Program. Through education, training, and pollinator garden and apiary creation, thousands have engaged in restoring bee populations and learning about their essential role in food production and ecological health.

Coffee farmers have also benefited from a PRAES project aimed at improving coffee quality and marketing. Training in production, processing, and branding has helped over 500 farmers boost incomes and access local and international markets, underscoring the economic value of specialty crops.

Projects integrating water harvesting, efficient irrigation, and renewable energy have helped producers tackle infrastructure issues. These efforts have improved water use, reduced nonrenewable energy reliance, and increased the sustainability of food production.

Together, these efforts reflect a holistic approach to food security through resilient plant and animal systems. With conservation, innovation, and education, Puerto Rico is building a stronger, more sustainable agricultural future.

The "Extreme Weather, Natural Resources, Environment, and Sustainable Energy" issue is also a priority for PRAEXS, with over 20% of projects addressing it. Key goals include improving water management for agriculture and promoting drip irrigation. Projects support biodiversity, especially in urban-rural transition zones, and evaluate improvements in soil health, quality, and fertility through biochar, cover crops, acidity management, and validated soil testing tools. These practices help farmers optimize yields with better information. PRAES supports this issue by promoting urban agriculture to improve food security and resilience. Programs address soil contamination, safe gardening, and biochar use, while outreach enhances community knowledge, soil health, and reduces dependence on imports.

In "Food Safety, Science and Technology," research has emphasized value-added processing to boost agricultural manufacturing and food security. Progress this year includes goat milk, coffee, and yam value-added products, which can support small-scale agro-industries.

The "Community, Economy and Sustainable Development" initiative focuses on strengthening local economies through sustainable agroecology, entrepreneurship, and local markets. PRAES delivered training on self-management, disaster preparedness, and cooperatives in both rural and urban communities. Community gardens and tech integration have promoted jobs, income, and food security. Partnerships enhanced outcomes, and education supports long-term sustainability.

At PRAEXS this is the smallest program, with two projects addressing agricultural labor shortages. Findings are expected to inform policies that improve labor efficiency in the coffee sector and address labor access issues faced by farmers island wide.

"Family and Well-Being" programs promote household and community food security through home gardening, healthy living, food preservation, and financial education. Special focus is given to older adults to promote healthy lifestyles and prevent chronic disease. Over 2,300 participants across Puerto Rico took part in hands-on learning experiences that improve household resilience and health.

The "Positive Youth Development" program advanced through 4-H initiatives such as “Teens Leading the Change” and “OYE.” These projects empowered youth in agriculture, STEM, and civic engagement, providing participatory, experiential learning that builds leadership, confidence, and a strong sense of community service.

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

High input costs and labor shortages remain the most significant challenges identified by farmers in recent studies on the outlook for agriculture in Puerto Rico. In the case of coffee and vegetables, labor shortages, especially during harvest, have been exacerbated by recurring hurricanes and other natural disasters since 2017. The two research projects highlighted by PRAEX under this critical issue explore different facets of this complex problem. In coffee, research focuses on evaluating alternative harvesting methods to improve labor efficiency and coffee quality, while a broader food system project explores how different types of operators are dealing with labor access issues with the goal of formulating policy recommendations that address their needs. Combined with progress in activities documenting potential relationships between major diseases in rural areas and declining agricultural production, these projects are advancing the research and education agenda established in our POW for the regeneration of agriculture and employment.

PRAES "Community self-management, economic development, and volunteers resilient projects during critical times" is a transformative program designed to empower communities across the island to build resilient, inclusive, and sustainable local economies. Rooted in the principles of community self-management, agroecology, and collaborative development, this program supports economic revitalization by strengthening local production systems, encouraging responsible consumption, and reducing reliance on external markets. By fostering sustainable entrepreneurship, environmental stewardship, and food sovereignty, the program addresses both economic inequality and ecological challenges, particularly in vulnerable and underserved regions.

At the heart of the initiative lies a comprehensive and multi-faceted strategy that equips individuals and communities with the tools and knowledge needed to generate long-term socioeconomic impact. The program prioritizes capacity-building through a wide range of educational offerings, including workshops, advisory sessions, radio programming, and hands-on training focused on entrepreneurship, disaster preparedness, agroecological production, and community governance. These activities are delivered across PRAES's four geographic regions, ensuring broad reach and localized impact.

A flagship component of this initiative is the Community Gardens Project, developed in partnership with the USDA Natural Resources Conservation Service (NRCS). This project has established eleven gardens and one high wind tunnel in ten geographically and economically marginalized communities across Puerto Rico, such as Vieques, Culebra, and Maricao. These gardens serve as hubs for education, food production, and collective action. With support from 22 extension agents and 51 community leaders, over 3,500 square feet of cultivated space have been created, rainwater harvesting systems have collected over 100,000 gallons, and composting and food preservation practices have been implemented. The initiative has not only increased the availability of fresh produce but also generated new income streams through the commercialization of products like juices, sofrito, and desserts, resulting in over $1,000 in direct community earnings.

Beyond economic gains, the program focuses on empowering specific community groups. Farmers benefit from training in sustainable agricultural methods, marketing strategies, and cooperative development. Youth are supported through innovation and entrepreneurship programs, gaining exposure to digital tools and leadership opportunities. Families, particularly those in socioeconomically challenged urban and rural zones, are provided with access to nutritious local food, training in home-based entrepreneurship, and support for establishing self-sufficient food systems. At the broader level, communities benefit from the formation of cooperatives, producer associations, and collaborative economic networks that encourage participatory governance and shared prosperity.

This program also incorporates elements of emergency preparedness and community resilience. Through 27 specialized courses reaching over 200 community leaders, participants have learned about risk management, emergency food planning, and natural disaster responses, equipping them to face environmental and economic shocks with greater confidence and coordination. Strategic meetings with PRAES Advisory Boards (CASEA) have further reinforced collaborative planning and institutional support for long-term growth.

The initiative's educational impact extends to university students as well, offering hands-on, interdisciplinary learning opportunities in agricultural economics, natural sciences, rural sociology, and community psychology. Their involvement enhances both community outcomes and the academic development of future professionals committed to sustainability and public service.

These interventions stand out for cross-sector collaboration and integration of traditional knowledge with innovation. It strengthens the social fabric through collective problem-solving and participatory decision-making, while also addressing critical environmental issues like resource conservation, carbon footprint reduction, and biodiversity protection. It represents a holistic approach to development--one that recognizes the interdependence of economic vitality, environmental health, and community well-being.

Through strategic investment in education, leadership, infrastructure, and grassroots mobilization, the Community Economy for Sustainable Development critical issue is setting a precedent for how localized, sustainable models can serve as powerful engines for transformation. By cultivating strong, interconnected, and self-reliant communities, the program is not only creating immediate benefits but also laying the foundation for a more equitable and resilient future for Puerto Rico.

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

Changes in temperature, rainfall patterns, and global population growth are forcing us to modify the way we manage our agricultural practices. Under these conditions, the efficient use of water for agricultural production becomes extremely important. At PRAEX, designing and promoting the use of an efficient drip irrigation system for agricultural production is one of the main objectives of our program. Water and irrigation management have been addressed for crops such as coffee, avocado, and citrus. Although coffee is primarily produced in Puerto Rico's mountainous region, where high rainfall is recorded, it is not evenly distributed. This creates the misconception that an irrigation system on a coffee plantation is unnecessary, but the results have demonstrated the benefits of installing a drip irrigation system to increase plantation productivity. Another core focus of our research program is the improvement of soil health, quality, and fertility by evaluating the use of amendments such as biochar, planting cover crops, managing soil acidity factors, and validating available soil testing tools to provide clear and consistent fertilizer recommendations. This year, we evaluated how the addition of biochar and Xanthan, a biopolymer derived from Xanthomonas, can improve the quality of an Oxisol soil from the Coto series.

We also examined how these amendments impact the growth, nutrient, antinutrient levels, and overall quality of Phaseolus vulgaris. In other experiments, very acid soil series with high levels of exchangeable Al3+ , common in the mountainous areas of inland Puerto Rico, were sampled and analyzed for pH and available P. Exchangeable Al3+ analyses are in progress, and these soil series will be included in future trials to determine liming rates and analyses of extractable Al3+ fractions.

Fertilizer consumption in vegetables is among the highest of all commodities, but there is limited scientific evidence, based on local crops and soils, to support current recommendations for phosphorus (P) and potassium (K) fertilizer rates for vegetable production. Experiments were conducted on different farms with diverse soils and crops grown, and with field-sites where soil test P and K showed spatial variability. Interpretation of the preliminary data collected validated that crop response to fertilizer-P does not occur when the soil test P is in the high category. In contrast, the crop response to fertilizer-P was observed when soil test P was in the low category. This finding is important because it demonstrates that soil test P can be used as a tool to distinguish when fertilizer-P should be applied.

The quest for more sustainable crop management practices is also advancing in the case of coffee, with the search for more eco-friendly alternatives to chemical insecticides for controlling the coffee leaf miner. In Puerto Rico, high-altitude coffee plantations are more exposed to winds and are more prone to damage from this pest. The use of windbreaks can reduce these effects by increasing relative humidity and favoring the presence of natural enemies. To test this idea, windbreaks composed of pigeon pea (Cajanus cajan L.) and Chrysopogon zizanioides L. (pacholÃ, vetiver) shrubs have been strategically located in an experimental coffee field. Preliminary results indicate a significant 20% increase in relative humidity, compared to the control farm (without windbreaks) over a six-month period. These windbreaks also modulate the microclimate, helping to maintain more stable humidity conditions in coffee plantations, which has resulted in a 30% reduction in the incidence of the coffee miner compared to the control group.

Challenges to food security in Puerto Rico, especially in the wake of hurricanes and other extreme weather events is the most pressing issue to PRAES. These disasters frequently disrupt supply chains, leaving urban communities vulnerable to food shortages. As climate change intensifies the frequency and severity of such events, the need for resilient, local food systems have become more urgent. Urban agriculture has emerged as a viable solution to increase food access, improve community resilience, and promote environmental sustainability. However, the presence of soil contaminants--particularly heavy metals and legacy organic pollutants--poses serious health risks and barriers to the growth of urban farming.

This initiative addresses those challenges by promoting safe, sustainable urban agriculture practices across Puerto Rico. The overall goal is to enhance food security and self-sufficiency by educating and equipping urban communities to grow their own food safely, even in contaminated environments. The initiative centers on three main objectives: (1) promote home and community gardening through education and training; (2) develop and disseminate safe farming practices that reduce exposure to soil contaminants; and (3) evaluate the effectiveness of biochar as a soil amendment for rehabilitating contaminated soils and improving crop yields.

Target audiences include urban gardeners, small-scale farmers, families in densely populated areas, seniors, youth in 4-H programs, Master Gardeners, agricultural extension agents, and researchers. Each group benefits from tailored outreach efforts, including hands-on workshops, training materials, and access to scientific research. Families and seniors gain access to fresher, locally grown produce; youth programs receive new tools and

knowledge to support lifelong learning; and professionals in the agricultural sector help test and scale innovative practices like biochar application.

A series of high-impact activities were implemented to reach these goals. These included educational workshops, demonstration plots, virtual and in-person training sessions, and field day tours showcasing biocharÂ´s potential to mitigate soil contaminants and improve fertility. Two major workshops drew more than 100 participants from across the agricultural sector. The first, "Enmiendas Organicas: Una Estrategia de Mitigacion para el Suelo y Cultivos" (December 2023), focused on organic soil amendments and mitigation strategies. The second, "Aplicaciones de Biochar para el Bienestar del Suelo y los Cultivos" (May 2024), highlighted biochar's benefits for soil and crop health. Both events took place at agricultural experimental stations near Puerto Rico's largest urban centers.

Additional outreach included scientific presentations at major local and international conferences. Findings on urban soil contamination and biochar applications were shared at the 2024 Puerto Rico Vegetable and Basic Grains Association meeting and the Soil Science Society of America's Bouyoucos Summer Conference. The project team also presented a workshop to 47 agricultural agents on soil sampling and nutrient analysis and hosted a soil tour for international experts visiting Puerto Rico.

The project's research components contributed new knowledge to the field, particularly regarding the quantification of heavy metals in Puerto Rican soils and the practical use of biochar for remediation and crop production. These findings were presented in peer-reviewed conference abstracts and posters.

Long-term outcomes of this initiative include an increase in urban gardens, greater food production in cities, broader use of biochar and organic waste products, and the development of new specialty crops adapted to urban environments. These impacts collectively strengthen Puerto Rico's food system, reduce dependence on imports, and enhance community health and resilience.

Ultimately, this project delivers clear public benefits. It helps secure a more sustainable, localized food supply while reducing environmental risks and improving soil health. The initiative also supports economic development by creating new opportunities for organic waste reuse and urban farming ventures. By fostering a culture of self-reliance and environmental stewardship, this work contributes to a more resilient and sustainable future for Puerto Rico.

**Critical Issue: Family well-being**

Food security remains a persistent challenge in Puerto Rico, making it essential to ensure access to affordable, healthy, and safe food for all. Educating communities on nutrient-dense food consumption, safe food handling, home and community food production, as well as food preservation and value-added practices, plays a crucial role in strengthening food security.  PRAES Food Security Program at the household level program aims to ensure that individuals, families, and communities in Puerto Rico have consistent access to affordable, nutritious, and safe food. By encouraging the cultivation of nutritious, home-grown food and food preservation techniques this will result in increased food security at both the household and community levels.  The program serves adults at all stages of development, helping them adopt food safety and food security practices to improve their overall well-being.

The diverse educational methodologies implemented were instrumental in achieving the set objectives: 302 individuals adopted safe food handling practices at home; 385 individuals increased their food

security by consuming nutritious food from home gardens; 467 individuals preserved food, enhancing the food security of their families and communities; 141 individuals established a 14-day food reserve.

Poverty in Puerto Rico affects more than 40% of the population, including children, youth, adults and the elderly. Weather events and inflation continue to exacerbate social, economic, and public health problems. It is important to continue educational activities so that families can strengthen their resilience to these challenges by improving access to healthy food, financial stability, the well-being of older adults, and family relationships.

The Healthy and Sustainable Families Program target audiences included adults who gained education in personal finance management, consumer protection, and access to healthy food; older adults who received strategies for healthy aging and support in strengthening their social networks and caregivers and families who benefited from training in positive parenting techniques and fostering healthy family relationships.

The implementation of diverse methodologies has been essential in achieving the established objectives. In strengthening family health and nutrition, 385 participants have improved their consumption of nutritious foods and increased physical activity. In promoting financial stability, 64 participants have enhanced their money management practices, while 11 have improved their economic and social conditions. Regarding the well-being of older adults, 228 individuals have acquired skills to enhance their quality of life in old age. Additionally, in strengthening family structure, 163 participants have reinforced their family relationships.

The broader public benefited from this program as it enhanced the quality of life for low-income individuals by providing education on healthy nutrition, personal finances, and overall well-being. Education equips individuals with knowledge and strategies to make informed decisions, empowering them to adopt positive behaviors. Moreover, it plays a crucial role in human development and its connections within families and communities. By fostering holistic human development, the program contributes to healthier individuals, stronger families, and more resilient communities.

Puerto Rico's population faces high rates of chronic-degenerative diseases, infectious illnesses, obesity in both adults and children, as well as breast and cervical cancer, impacting overall health and well-being. These challenges highlight the urgent need to address this issue to promote a healthier population and improve quality of life.  The Family well-being program target audiences include children, young people, and adults who will develop strategies for healthy eating, regular physical activity, and other habits to prevent chronic-degenerative diseases. In addition, adults will gain awareness of the importance of early detection of breast and cervical cancer.

The diverse educational methodologies implemented were key to achieving the established objectives. A total of 432 individuals adopted practices that promote healthy lifestyles; 12 individuals implemented measures to prevent chronic-degenerative diseases; 56 individuals took steps to prevent infectious diseases, and 97 women acknowledged the importance of early detection of breast and cervical cancer.

This program aims to promote healthy lifestyles by encouraging the adoption of physical, mental, and social well-being practices.  Through education and promotion of healthy lifestyles, we contribute to the health and well-

being of individuals, families and communities for the prevention and early detection of diseases, and the improvement of their environments.

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

In line with the objectives of our POW, research activities in this area have focused on studying processing methods that add value to crops and livestock products, which in turn can boost manufacturing industries that can contribute to the island's food security. Manufacturing processes with potential for improving the marketability of goat milk, specialty coffees and yams were advanced last year. For goat milk, various products not currently produced in Puerto Rico were developed, such as "dulce de leche" and yogurt with goat milk and blends of goat milk and cow milk, and comparisons of their physical and chemical properties were evaluated. In the case of coffee, an evaluation by Q grader panelists of the LimanÃÂ variety fermented with different strains of wine yeast resulted in the classification of these coffees as specialty coffees, as opposed to those processed without yeast, which were borderline between premium and specialty. The project also advanced the development of better management practices for coffee fermentation that could reduce the potential for fungal growth that can be harmful to consumers's health.

Yams are one of Puerto Rico's most important root crops and essential for improving the island's food security, as they grow underground and can withstand the impact of hurricanes. Over the past decade, several research projects have focused on developing best management practices for yam cultivation with the goal of expanding production. As part of this initiative, studies were begun on how to transform fresh yams into flour that can be used in different products. Trials concluded last year demonstrated that it is possible to replace up to 25% of yam flour in bread formulations without affecting the sensory acceptance of the bread. The effect of extrusion parameters on the physical and functional properties of an extruded yam-flour snack was also determined, with favorable results that open the possibility of using yam flour to develop lightly salted extruded snacks.

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

The improvement of locally important crop varieties remains vital to promoting greater food security in PR. In pigeon pea, two indeterminate, photoperiod-insensitive breeding lines (IIPG-7 and IIPG-11) were released that can be used directly by producers or breeders to develop pigeon pea cultivars that can be planted year-round. Also, bean breeding research has resulted in the release of cultivars with resistance to BGYMV, BCMV, common blight and greater tolerance to low fertility soils.

Root crops such as sweet potatoes and yams are local staples capable of withstanding climatic contingencies. Studies on the causes of recent declines in sweet potato production revealed alarming populations of the reniform nematode in intensively produced sweet potato plantations. A biorational control program under development should reduce nematicide use and increase yield. In yam, the use of diseased and low-quality planting material exacerbates postharvest losses due to plant pathogens and inadequate storage systems. This year, the first batch of disease-free yam seeds was produced and evaluated in a field trial. Results showed that conventionally produced seeds had higher populations of nematodes, the causative agents of yam dry rot, compared to the tested seeds.

In Puerto Rico, watermelon is severely affected by vine decline, which reduces fruit yield and quality. Squash vein yellowing virus, transmitted by Bemisia tabaci, is the causal agent. Research confirmed that insecticide applications in watermelon fields are insufficient to prevent outbreaks of vector-borne viral diseases, as seedlings, usually germinated in open nurseries, are already infected with viruses. The use of an elicitor that has been

outstanding for virus management in melon elsewhere, was evaluated. Studies are also progressing on Amrasca biguttula and Megalurothrips usitatus, two non-native species recently introduced in Puerto Rico that also affect vegetable and grain crops in the south.

Finally, based on the evaluations of crop varieties and weed management practices adapted to organic or agroecological farming, recommendations were made regarding the vegetable and farinaceous varieties that demonstrated the best yield and performance. The best weed control techniques for these crops were also recommended.

In animal systems, research initiatives focus on improving cattle biological efficiency, establishing superior quality forages, increasing profitability, and devising practices that foster weather resilience. In dairy, results on the effects of an automatic milk feeder on the growth of slick and wild-type Holstein calves showed that robotic feeders improved dairy calf body weight at weaning and facilitated a smoother weaning transition. However, under heat stress conditions, slick dairy calves did not exhibit superior attributes than non-slick dairy calves at weaning, apparently limiting the advantages of the slick gene to the milking phase of dairy animals. Also, the results of studies of improved tropical pastures have allowed for more reliable soil fertility recommendations for forage production. As a result, forage yield and quality have improved. In cattle, experiments show Red Angus x Senepol cows have a numerically higher average pregnancy and weaning time than purebred Senepol cows. In addition, crossbred calves had higher average daily gains before weaning than purebred calves. Research evaluating the genomic association between slick-haired cattle breeds with Puerto Rican Criollo cattle is also advancing. And in small ruminants, breeding trials aimed at introducing a promising gene to improve the prolificacy of local sheep breeds showed that the resulting F1 progeny, known carriers of the Fec-B gene, had a higher pregnancy rate and a significantly higher incidence of twin births during their first lambing. In another study of Creole and crossbred lambs, results showed a slow growth rate of entire and castrated lambs fed under pasture conditions during the growing phase. Castration delayed the days on feed to reach target slaughter weight for crossbred lambs. Local producers could adopt these results to reduce the number of days lamb spends from feed to slaughter.

The Criollo cattle of Puerto Rico (CcPR), introduced by the Spanish in 1505, are a hardy, multi-purpose breed adapted to the island's climate and terrain. Once central to agriculture, their population is now declining due to inbreeding, modernization, and limited support. A needs assessment with 30 stakeholders led to 11 strategies to preserve the breed, including educational outreach, expert training, publications, a census, and improved collaboration. These efforts aim to conserve CcPR genetics, support rural farmers, and promote sustainable, culturally rooted livestock practices across Puerto Rico.

Puerto Rico's agriculture faces challenges from climate change, degraded soil, and high input costs. The initiative From Conventional Agriculture in Transition to Sustainable Agriculture offered 36 hours of theoretical and hands-on training in sustainable practices, including soil and water conservation, composting, and integrated pest management. A "Train-the-Trainer" model and strategic collaborations with USDA, NRCS and agricultural specialists expanded the program's reach. As a result, 50 farmers and professionals gained skills to improve farm sustainability, reduce costs, and enhance food security. The initiative strengthened local capacity, promoted resilience, and contributed to a more self-sufficient agricultural system that benefits both communities and the environment.

The Tissue Culture Plantain: Educating Farmers on Novel Practices initiative aimed to introduce Puerto Rican plantain farmers to the benefits of tissue culture technology, offering pest-free, high-quality, and wind-resistant

seedlings. By developing educational materials and collaborating with experts, PRAES highlighted sustainable practices like organic farming, integrated pest management (IPM), and precision fertilization. The efforts led to increased interest and adoption of tissue culture seedlings, improving farm productivity. As more farmers embraced these practices, the project contributed to enhancing food security and sustainability for the island's agricultural sector.

Bees are essential pollinators for ecosystems and food production. After Hurricane MarÃƒÂÃ‚Â a in 2017, Puerto Rico saw a dramatic 80% decline in bee populations, highlighting the need for sustainable pollinator management. The Honeybee Extension Program aims to strengthen bee populations through education, training, and hands-on activities like establishing pollinator gardens and apiaries. Over 200 community members, 300 4-H students, and 30 farmers were trained in pollinator protection, leading to increased awareness and engagement. Events such as pollinator festivals, field days, and workshops reached over 3,000 participants, fostering a more informed public about pollinator conservation and biodiversity.

PRAES project to enhance coffee quality and marketing opportunities trained over 500 small-scale coffee farmers to improve coffee quality and access better markets. Through workshops, farm visits, and the annual La Taza de Oro competition, producers learned best practices in harvesting, processing, and cupping. As a result, many increased their income, gained national and international exposure, and invested in new equipment. The program also trained Extension professionals and educated the public through expos and community events, strengthening Puerto Rico's specialty coffee sector.

The initiative "Development of Water Harvesting Facilities, Irrigation Systems, and Implementation of Renewable Energy Systems on Farms and Food Processing Facilities" advances agricultural sustainability and food security by promoting efficient water use and integrating renewable energy into irrigation systems. Training sessions equipped farmers, students, and professors with practical skills in irrigation assessment, installation, and water management. The program addressed critical challenges such as limited water access and lack of technical knowledge, especially in mountainous regions. Through expert guidance and hands-on support, participants learned to optimize irrigation systems, reduce operational costs, and improve crop sustainability. These efforts fostered awareness of responsible resource use and helped prevent costly errors in system selection. Ultimately, the program strengthened local food systems and promoted long-term environmental resilience.

**Critical Issue: Positive youth development**

The quality of a child's early experiences and interactions plays a crucial role in shaping brain development and establishing the foundation for future learning and growth. Evidence-based studies highlight the effectiveness of non-formal education in providing students with opportunities to acquire knowledge and develop essential life and scientific skills. In response to these challenges, Puerto Rico's 4-H program has developed an educational initiative "Teens leading the change for community wellness" aimed at empowering 4-H youth leaders to address community needs through science-based knowledge, leadership development, and community engagement. The program aims to develop a comprehensive initiative that extends beyond school settings, engaging Extension Educators, volunteers, and 4-H youth leaders in the acquisition of knowledge and the development of life and scientific skills. It seeks to increase youth participation in activities related to agriculture, family and consumer sciences, and STEM fields.

One of the major initiatives, the Entomology 4-H Bug Camp, introduced participants to fundamental entomology concepts, emphasizing the role of insects in food production, environmental diversity, and

global hunger reduction. This initiative allowed 20 youth participants to explore entomology, plant diseases, and professional careers in these fields. As a direct outcome of the camp, two students-initiated research in phytopathology, furthering their scientific interests.

Another impactful initiative was the 4-H Bee Aware Project, led by 4-H alumnus Jafet Santos, who developed his expertise in entomology through past 4-H projects. Jafet spearheaded educational activities focused on bee preservation in Puerto Rico, engaging 12 youth participants in learning about pollinator gardens and crop protection. For his leadership, Jafet was recognized as the 2024 4-H Pollinator Champion by the National 4-H Council. The project also secured a $2,000 scholarship from the National 4-H Council's "Teens Leading the Change" initiative, enabling further implementation of its activities.

Expanding on pollinator conservation efforts, the Pollinator Habitat and Ambassador Program responded to habitat loss caused by deforestation and extreme weather events in Puerto Rico. This initiative trained 21 4-H ambassadors in establishing pollinator-friendly gardens and educating their communities.

Another key educational initiative, the 4-H/4 Paws Project, focused on animal care and welfare, particularly for dogs and cats. Participants learned about animal protection laws and responsible pet adoption, with 60 youth acquiring valuable knowledge and contributing volunteer hours at animal shelters.

The 4-H youth in Fajardo County launched the School 4-All initiative, aimed at supporting students whose families struggle to afford school supplies. The youth leaders engaged in discussions on social justice and committed themselves to ensuring equal opportunities for all students. As a result, six families benefited from the program, and the 4-H team secured $1,000 in funding from the National 4-H Council's "Teens Leading the Change" initiative to expand their impact.

Through these diverse initiatives, the program not only empowered young people with knowledge and leadership skills but also fostered a deep commitment to community service, sustainability, and social responsibility.

Another major program to address this critical issue is OYE (Opportunity for Youth in Equity). The development of OYE was driven by our primary goal: to ensure that 4-H Puerto Rico fosters a welcoming, inclusive, and diverse environment where every young person feels a sense of belonging and empowerment.  Our 4-H Positive Youth Development (PYD) approach is based on the belief that when young people are given opportunities to explore their interests, experience a sense of belonging, build healthy relationships, and engage in diverse experiences, they grow into individuals who are more committed to creating positive change for all.

This program addresses the need for inclusive and safe spaces where all young people feel valued and empowered.  Two members of Collegiate 4-H at the Mayaguez Campus took the lead in developing En SeÃƒÂ±as, a series of educational clips that teach various topics using American Sign Language.  With youth and staff trained in American Sign Language (ASL), we implemented simultaneous ASL translation of the 4-H pledge at local, regional, and state activities. Our 4-H leaders have been recognized for their contributions to equity efforts and were invited to present the pledge at national

events, including the 2024 National 4-H Congress and National 4-H Conference. Additionally, 4-H Collegiate students are creating and sharing digital resources for the Deaf community on social platforms.  TLEI (The Leadership Equity Institute), sponsored by 4-H, has served as a foundational platform for Puerto Rico 4-H's OYE program. Since its creation, we have developed five teams and launched five projects that expand our impact across the archipelago, furthering our commitment to leadership and equity.  A 4-H team participated in TLEI 2024, where two youth members, a volunteer, and PRAES staff developed an action plan for CASA 4-H.  This initiative focused on creating cooperative and inclusive recreational activities for students in a rural school. For one team member, this experience marked her first time traveling and sharing her story about how OYE-VE and 4-H have empowered youth from foster homes like hers.  In addition, three OYE youth leaders collaborated with members of a blind association on field trips to pollinator gardens.  Another initiative within the OYE Program's goals was Tiznando el PaÃƒÂÃ‚Âs, an immersion initiative that encourages 4-H members to reflect on racism in Puerto Rico.

As a positive youth development organization, we are committed to creating interdisciplinary initiatives that ensure children and youth achieve the long-term 4-H PYD outcomes: academic and vocational success, civic engagement, employability, economic stability, happiness, and well-being. Through OYE, we have paved the way for 4-H to become a truly inclusive and safe space for all--La Casa de Todos--where every young person feels valued, supported, and empowered to contribute to their communities.

## Merit and Scientific Peer Review Processes

**Updates**

None for PRAEXS

During FY 2024 PRAES moved away from the planned plan that was originally designed to help reach and maintain contact with institutional collaborators and stakeholders during the COVID-19 pandemic. The proposed plan continued the established strategy of contacting and collecting stakeholders and collaborators inputs through surveys and other physical contactless strategies.  Planning and Evaluation Office in conjunction with the Extension Assistant Dean and the Extension Programmatic Leaders has set into place surveys and phone call instruments to collect stakeholder´s input. With the end of the Covid-19 pandemic on May 2023, just days after the submission of FY2024 POW, PRAES began working into reestablishing in person strategies to conduct both the Merit and Stakeholders Review processes.

## Stakeholder Input

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

During FY2024, PRAES undertook a focused initiative to update and reorganize the Agricultural Extension Service Advisory Committees (CASEA) across the island. With the recruitment of twenty-one new Agricultural Agents and Family Science Educators, the goal was to strengthen connections between newly appointed personnel and existing farmers, community leaders, and their organizations.

This effort aimed to foster greater collaboration, improve outreach, and ensure that Extension services remain responsive to the evolving needs of Puerto Rican communities.

None for PRAEXS

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

None for PRAEXS.

None for PRAES

**Methods for collecting stakeholder input and brief explanation**

Ten strategic meetings were held with 104 members of CASEA, representing PRAES four geographic regions. These efforts have strengthened community networks and laid the groundwork for continued collaboration and growth.

None for PRAEXS

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

Meeting transcripts were thoroughly analyzed for content, frequency, and impact, providing valuable insights that were directly incorporated in the development and refinement of PRAES FY2024 action plan.

Stakeholder input continues to be used to justify new faculty recruitments with full or partial research appointments at the PRAEXS. Needs identified by stakeholders and advanced in our past year POW included the hiring of faculty with expertise in cropping systems and climate change interactions, precision agriculture, agricultural economics, rural sociology, and farming under structures or protected agriculture. We will continue to review this recruitment plan yearly. Stakeholder input on our priority-setting process was also considered and incorporated into our Hatch 2025 call for proposals. Annual revisions of stakeholders' concerns will continue to inform future program changes, including budgets and updates of critical issues.

Stakeholders continue to stress, both in meetings and in commodity surveys, concerns about the availability of seeds and planting materials, insufficient farm laborers, and the perceived increase in pests and diseases attacking crops. Within our limited staff and budget resources we continue to address these concerns in our research program.

## Highlighted Results by Project or Program

| Type | Projects / Programs |
|---|---|
| **Projects / Programs without a Critical Issue** | **0** |

**Not Provided**