

2020 Annual Report of Accomplishments and Results

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

I. Report Overview

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

1. Executive Summary (Optional)

This annual report combines what the University of Puerto Rico's Agricultural Experiment Station (PRAEXS) and Agricultural Extension Service (PRAES) consider to be our most salient research and educational achievements during FY2019-2020. Puerto Rico continues recovering from the 2017 hurricanes, the 2020 earthquakes and the COVID-19 pandemic that have tremendously impacted all aspects of life on the island.

-19 curfews and regulations by executive order As the accomplishments reported suggest, important research and extension activities took place last year, benefiting farmers, communities, youth and other stakeholders that were still recovering from the hurricanes' devastation and had to adapt quickly to the new circumstances brought about by the earthquakes and COVID-19. Progress was achieved while the institution faced the challenges of rebuilding the damage suffered in vital infrastructure facilities, while researchers continued to face limitations in accessing experimentation fields and laboratories, and while Extension Agents and Educators lacked their habitual spaces and methods (face-to-face) to train their clientele due to strict COVID. All this was framed in the context of a worsening economic situation overall that continues to affect the budget assigned to the state university. Lessons learned from previous disasters had to be quickly put into practice under a transformed reality that has changed our usual way of conducting business and meeting our goals. Example are the immediate digitalization of the most relevant educational materials, development of courses in virtual format, and reinforcement of our online communications platforms to extend our reach to our clientele in an accessible and practical approach (e.g., Facebook pages, YouTube channels)

This year we are reporting accomplishments and results from the six Critical Issues defined in the POW prepared during 2018-19 for a new five-year cycle. The current "**Food Security, Plants and Animal Systems**" critical issue includes practically all our research and extension activities directly related to farming. As the 2019 POW suggested, our work has continued to emphasize research and extension efforts that address the most important production constraints faced by our stakeholders. Salient extension activities and research projects were directed towards increasing local food security through new disease-resistant varieties, high-quality seeds, better business and marketing strategies, expanding home-school-community gardens and addressing the challenges faced by local livestock industries. The activities reported under this critical issue are:

1. Adopting business and marketing strategies to increase food production
2. Improving bean health and production
3. Increasing genetic resources of tropical crops with disease resistance
4. Increasing food availability by improving local agricultural production and agri-business marketing strategies.
5. Home, School and Community Gardens
6. Citrus germplasm testing to improve citrus production
7. Plant Diagnostic Clinics
8. Improving the Quality of Puerto Rican Coffee
9. Genetic and management strategies to reduce the effects of heat stress in cattle
10. Intensive training for intensive changes: The calf education program
11. Beef cattle and small ruminants as a strategy to increase local food security

The current "**Extreme Weather, Natural Resources and Environment, and Sustainable Energy**" critical issue combines extension educational efforts and research projects fostering natural resource protection and agricultural resilience in the face of increased climate variability and extreme weather events. Prominent projects and activities include:

12. Natural resource protection amid extreme weather and natural disasters
13. Soil quality assessment among soil orders and ecological zones in Puerto Rico
14. Sustainable pig production in Puerto Rico
15. Innovation for a sustainable forestry industry
16. Wild beehives as an assessment of melliferous plant, bee and honey quality

Our **Food Safety, Science and Technology** critical issue continues integrating the extension goal of targeting individuals and the food industry sector to adopt food safety handling practices with research in the food science technologies that develop new, added value, and safe food products. Featured projects and activities include:

17. Elaboration of flour and extruded *apio* products (*Arracacia xanthorrhiza* Bancroft) as an alternative for the use and commercialization of this crop
18. Value added products from plantains
19. Preventing foodborne illness dissemination through education and certifications

Under the **Community, Economy and Sustainable Development** critical issue PRAES and PRAEXS continue to offer a joint socioeconomic perspective on the major problems affecting farming and communities in Puerto Rico, and the research/extension-oriented alternatives advanced to partially address them. Studies and activities depicted this year are:

20. Facing adversity through community economic development, disaster management, and volunteer training programs
21. Consumers of differentiated coffees are willing to pay more than twice the price of regular coffee in Puerto Rico

The **Family and Well-Being** component continues promoting healthy behaviors, disease prevention, and family resources management to improve the quality of life of our vulnerable populations. Our health educational program developed multiple trainings for the general public; however, a more aggressive program focused on COVID-19 prevention with particular attention to the elderly and their caregivers. The activity reported under this critical issue was:

22. Health promotion and disease prevention for the elderly and caregivers during the COVID-19 pandemic

The **Positive Youth Development** component continues creating safe learning spaces, establishing positive contacts, and providing opportunities and experiences for children and youth to develop skills and abilities to become healthy individuals that contribute positively to our society. The lack of educational opportunities and inaccessibility to food due to closing of schools, the economic challenges, and a more alarming situation, domestic violence, exacerbated by the COVID-19 lockdown, increase youth vulnerability. These challenges are a potential physical and emotional threat to children and adolescents. This year, the program focused efforts on the following activity:

23. Access, Equity and Opportunity; the Power of Youth.

II. Merit and Scientific Peer Review Processes

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

Process	Updates
1. <u>The Merit Review Process</u>	No significant updates to what was stated in our 2022-2026 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 20221-2026).
2. <u>The Scientific Peer Review Process</u>	An annual call for proposals which includes the year's revised research priorities is prepared and distributed by the recently integrated Research and Sponsored Programs Office. This new office combines research and externally funded activities for both the Agricultural Experiment Station and the Agricultural Extension Service. Proposals are submitted to the Assistant Dean for Research with the preliminary endorsement of the respective Department Head. The Assistant Dean for Research sends the proposal to a local peer reviewer and an external reviewer for their written comments on the scientific merit of the proposed research and compliance with the PRAEXS strategic plan. Reviewers are instructed to use a template which specifies the evaluation criteria and their value. Among other criteria reviewers must assess the technical competence of the proposals and their feasibility (i.e., the capacity of the Principal Investigator and his team to carry out the research objectives). Proposals and their reviewers' input are discussed and evaluated by the CAS Associate and Assistant Deans for Research, and a final decision is taken by the administration.

III. Stakeholder Input

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

Stakeholder Input Aspects	Updates
1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation	No significant updates to what was stated in our 2022-2026 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2022-2026).
2. Methods to identify individuals and groups and brief explanation.	No significant updates to what was stated in our 2022-2026 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2022-2026).
3. Methods for collecting stakeholder input and brief explanation.	No significant updates to what was stated in our 2022-2026 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2022-2026).
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	No significant updates to what was stated in our 2022-2026 Plan of Work (The University of Puerto Rico Combined Research and Extension Plan of Work 2022-2026).

IV. Planned Program Table of Contents

No.	Program Name in order of appearance
1	Food Security, Plant & Animal Systems
2	Extreme Weather, Environment & Sustainable Energy
3	Food Safety & Science Technology
4	Community Economy for Sustainable Development
5	Family Well-Being
6	Positive Youth Development

V. Planned Program Activities and Accomplishments

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

No.	Title or Activity Description	Outcome/Impact Statement <i>Descriptions of each element on page 3</i>	Planned Program Name/No.
1.	Adopting business and marketing strategies to increase food production	<p>What is the issue? Puerto Rico imports more than 80% of food consumed locally. Imported food travels long distances from point of origin to the island, situated in the hurricane belt. One way to overcome our food susceptibility is by improving the marketing strategies of our local agribusiness.</p> <p>Target audience Farmers and growers were trained in tools to develop and improve their marketing approaches to better their sales.</p> <p>What has been done? PRAES county agents and specialists provided individual assistance and training to 1,574 farmers in farm management, feasibility analysis, business plans, marketing strategies and networks to promote the sales and production of local food.</p> <p>Results After participating in the PRAES training in business and marketing, 111 farmers reported adopting computers as a management tool for their business, 61 prepared business plans, 17 acquired loans to improve their business, 91 new agricultural projects were established, 107 farmers increased their business, 55 increased production and 135 adopted innovative marketing strategies for their agribusiness.</p> <p>External Factors (optional) Due to the 2020 earthquakes and COVID-19 pandemic most trainings scheduled were postponed.</p> <p>Other information such as relevant websites is optional. N/A</p>	Food Security, Plant & Animal Systems

2.	Improving bean health and production	<p>What is the issue? <i>Phaseolus vulgaris</i> L. is an important crop in the United States, with a one-billion-dollar farm gate value, and the most important pulse crop worldwide. Fungal, bacterial, and viral diseases are among the main production constraints, while extreme weather events, soil mineral deficiencies, and short growing seasons reduce output. It is essential for common bean sustainability to improve bean yield potential by incorporating resistance/tolerance to major biotic and abiotic stresses, broadening the genetic base, and developing genomic resources. Identifying and implementing sustainable agricultural systems that improve bean seed yield, conserve natural resources, and protect the environment are also within the scope of our work.</p> <p>Target audience Farmers in Puerto Rico who use improved bean cultivars developed by PRAEX bean breeders. The scientific community that learns about results through the project's publications and presentations at scientific meetings.</p> <p>What has been done? Bean breeding lines have been developed that combine multiple virus resistance and resistance to bruchids. To continue with this work, a crossing block was conducted during the summer of 2020. The crossing block included snap bean lines from the UPR bean breeding program that have the <i>I</i> gene for resistance to BCMV and the <i>bgm-1</i> gene for resistance to BGYMV. The PRAEX lines were crossed with the snap bean cultivars 'Jade' and 'Contender' with the goal of producing progeny possessing resistance to viruses and improved horticultural traits. Second filial seeds were produced in a screenhouse at the USDA-ARS Tropical Agriculture Research Station.</p> <ul style="list-style-type: none"> The virulence of <i>Fusarium solani</i> isolate ISA-Fs-008 was characterized in the BASE 120 nursery and in 26 <i>Phaseolus vulgaris</i> genotypes with contrasting reactions to the pathogen 19-00504. 	Food Security, Plant & Animal Systems
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- A field trial was also planted at the Isabela Substation in October 2020 to screen 96 bean cultivars and elite breeding lines for web blight resistance.

Results

Bean lines expressed different reactions to BCMNV. Pinpoint necrotic lesions were observed in line 2015-52-1. Top necrosis was observed on PR-16-8. Systemic necrosis was observed in 2015-17-1. Lines PE16-5, 2015-68-1, 2015-9-3B and 2015-9-3A developed top necrosis. In line 2015-52-1 local pinpoint necrotic lesions developed. 'Jade' showed mild mosaic and 'Contender' did not show any reaction. The ELISA test results were negative for all the lines tested. The experiment was replicated in November 2020, and the results were similar.

In the elite breeding lines trial, results show that the pedigrees of the most resistant lines are diverse, suggesting that they are good candidates to be used as parents to create a base population for another cycle of recurrent selection for web blight resistance. Seed yield and % damaged seed will be additional criteria for selection of parents for the next cycle of recurrent selection for web blight resistance.

- Screening against *Fusarium solani*: The virulence of *Fusarium solani* isolate 19-00504 was inoculated in 26 genotypes and the contrasting disease severity score identified four genotypes with resistance to the isolate.

External Factors (optional)

The COVID-19 pandemic caused a disruption of greenhouse and field research activities. Numerous field trials of promising bean breeding lines were prepared but not planted during 2020 due to the COVID-9 pandemic quarantine. The planting of Andean bean field trials was delayed from November 2020 until February 2021.

Other information such as relevant websites is optional.

Cultivar and Germplasm releases: A paper describing the release of the pinto bean lines PR1572-19 and PR1572-26 was published in the J. Plant Reg. A paper identifying recent

		<p>releases of bean cultivars in Central America and the Caribbean was published in the 2020 Annual Report of the Bean Improvement Cooperative.</p> <p>Publications</p> <ul style="list-style-type: none"> • Beaver J.S., González A., Godoy-Lutz G., Rosas, J.C., Hurtado-González, O.P., Pastor-Corrales, M.A. and T.G. Porch. 2020. Registration of PR1572-19 and PRPR1572-26 pinto bean germplasm lines with broad resistance to rust, BGYMV, BCMV, and BCMNV. J. Plant Regist. 2020;1–7. https://doi.org/10.10002/plr2.20027. • Beaver, J.S. 2020. The production and genetic improvement of beans in the Caribbean. Ann. Rep. Bean Improv. Coop. 63:7-12. • Rosas, J.C., Beaver, J.S. and T.G Porch. 2020. Bean cultivars and germplasm released in Central America and the Caribbean. Ann. Rep. Bean Improv. Coop. 63:107-108. • Beaver, J.S., Estévez de Jensen, C. Miklas, P.N. and T.G. Porch. 2020. Contributions in Puerto Rico to Bean, <i>Phaseolus</i> spp., research. J. Agric. Univ. Puerto Rico. 104:43-111. https://doi.org/10.46429/jaupr.v104i1.18287 • Oladzad A., A. González, R. Macchiavelli, C.E. Estévez de Jensen, J.S. Beaver, T.G. Porch and P. McClean. 2020. Genetic factors associated with nodulation and nitrogen derived from atmosphere in a Middle American common bean panel. Front. Plant Sci. 11:576078. doi: 10.3389/fpls.2020.576078. • Soler-Garzon A., Oladzad A., Lee R., Macea E., Rosas J.C., Beaver J., McClean P., Beebe S., Raatz B., and P. Miklas. 2020. Genome-wide association and fine mapping of <i>bgm-1</i> gene and other QTLs for resistance to <i>Bean golden yellow mosaic virus</i> in dry beans. Ann. Rep. Bean Improv. Coop. 63:87-88. 	
3.	Increasing genetic resources of tropical crops	<p>What is the issue?</p> <p>Plant genetic resources are the building blocks of genetic variability upon which scientists conduct research and develop improved cultivars and products. To improve Puerto Rico's food security, farmers need new varieties and high-quality seeds. This</p>	Food Security, Plant & Animal Systems

<p>with disease resistance.</p>	<p>project acquires, regenerates, maintains, characterizes, evaluates, documents, distributes, and utilizes plant genetic resources of value to agriculture.</p> <p>Target audience The principal target audience for this project were small to mid-sized farmers and consumers of locally grown fresh and minimally processed tropical fruits, bananas, plantains, root crops, coffee, common beans, pigeon peas and forage adapted for the tropical zone. Also, Department of Agriculture agronomists, private institutions, and the scientific community.</p> <p>What has been done? PRAEX has acquired and conserved genetic resources of <i>Musa</i> spp., sorghum, peanut, watermelon, chili peppers, warm-season grasses, cowpea, clover and tropical/subtropical legumes. It has distributed genetic resources and associated information to researchers, educators, and plant breeders in the Southern Region of Puerto Rico and worldwide. Propagation material from the plantain, banana and tuberous crop collections were distributed to local farmers in 19 municipalities. Citrus scions of Mexican lime (ML), fine clementine mandarin (FCM) and Campbell Valencia orange (CVO) in three rootstocks (Swingle, HRS 812 and HRS 897) were produced under fertigation practices at the Isabela Substation. Canopy volume, fruit production, and lower rootstock/scion ratio were recorded 29 months after planting. Seeds of twenty pigeon pea genotypes were reproduced and preserved, guaranteeing the availability of valuable germplasm for growers and scientists in Puerto Rico, U.S., and worldwide.</p> <p>Results Forty-three <i>Musa</i> spp. genotypes were conserved and maintained at the PRAEX Corozal Substation. The banana variety FHIA2 (Monalisa) is under evaluation for nematode response and analysis for its potential for commercial production. A new plantain variety, FHIA20, was added to the collection for its increment and further agronomic response in the mountainous region. Five apio (<i>Arracacia xanthorrhiza</i> Bancroft), 29 cassava (<i>Manihot esculenta</i> Crantz), 30 sweet potato (<i>Ipomoea batatas</i> L.), and 22 yam</p>	
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(*Dioscorea* spp.) accessions are conserved at Corozal, Adjuntas and Isabela Substations. The genetic characterization of cassava has been initiated. Two sweet potato varieties are under multiplication for further evaluation of its potential for commercial production. Sweet potato requests from local farmers account for 55% of total requests for varieties of the Corozal AES collections. Two tanager varieties developed at PRAEX, "Nazareno" and "Vinola", are under agronomic evaluation for potential release to farmers. A study of cowpea 'Iron Clay', 'Mouride' and lines 524B and CB 27, CB 46, and IFE brown has shown the potential of the CB 46 line for commercial forage in Puerto Rico during the short days, requiring further assessment during the summer months.

Pigeon pea cultivar 'Lazaro' was released. This cultivar can be planted the whole year and will benefit growers because fresh pigeon pea will be produced at the peak of consumption (Thanksgiving and Christmas holidays).

The Physicochemical and quality characteristics of 18 quenepa clones were compared. Quenepa cultivars have significant differences ($p < 0.0001$) in total soluble solids, pH and total acidity. The percent of pulp ranged between 42.66 to 63.52% and was not correlated with weight. The sensory evaluation indicated that the overall flavor is related positively with sweetness, juiciness, less acidity and astringence. Based on the overall flavor evaluation, 'Cesar Ramos' and 'Sabana Grande' were the most appreciated cultivars, followed by 'Tuna'.

Two virtual conferences were offered via You Tube: one on vegetative propagation material in starchy crops and the other, on the identification of Plantain and Banana wilting by *Fusarium* spp. Tropical Race 4

External Factors (optional)

The research activities of this project were affected differently by the COVID-19 pandemic and January 2020 earthquakes, depending on the location of the activity. At the Adjuntas and Corozal Substations part of the field work was lost and will have to be repeated. UPRM students could not access labs to conduct analyses until August 2020.

		<p>At the Isabela Substation, however, work is only a few months behind schedule and expectations are that objectives will be accomplished in a timely manner.</p> <p>Other information such as relevant websites is optional.</p> <p>Publications:</p> <ul style="list-style-type: none"> • Viteri, D.M., Bosques, A. Linares, A.M. Huynh, B., Roberts, P., Sarmiento L., and Pérez, M. 2020. Registration of photoperiod insensitive pigeonpea cultivar 'Lázaro'. Journal of Plant Registrations 14: 97-101. https://doi.org/10.1002/plr2.20000 • Tirado-Corbalá, R., Segarra-Carmona, A., Matos-Rodríguez, M., Rivera-Ocasio, D., Estévez de Jensen, C., and J. Pagán. 2020. Assessment of Two Sweet Orange Cultivars Grafted on Selected Rootstocks Grown on an Inceptisol in Puerto Rico. Horticulturae 2020 6(2):30; https://doi.org/10.3390/horticulturae602003 	
4.	<p>Increasing food availability by improving local agricultural production and agri-business marketing strategies.</p>	<p>What is the issue?</p> <p>Puerto Rico imports more than 80% of local food consumed. Imported food travels long distances, from point of origin to the island, situated in the hurricane belt. This is the main reason for our food supply chain vulnerability. After the critical situations recently caused by hurricanes, earthquakes and now, the pandemic, Food Security has become a topic of great interest to our PRAES Agents and Educators. One way to overcome our food susceptibility is by improving the marketing strategies and local agricultural production through intensive educational activities.</p> <p>Target audience</p> <p>Farmers and growers who acquired knowledge about tools to develop or improve their marketing approaches in order to improve their sales and therefore their agribusiness production.</p> <p>What has been done?</p> <p>Forty-seven PRAES county agents included topics related to Food Security in their educational interventions, benefiting 3,722 participants. Eighty-five farmers received</p>	<p>Food Security, Plant & Animal Systems</p>

		<p>training on marketing strategies, and specialists provided individual assistance and training to 1,574 farmers on farm management, feasibility analysis, business plans and marketing strategies and networks.</p> <p>Results A total of 111 farmers adopted computers as management tools, 61 prepared business plans, 17 acquired loans; 91 new agricultural projects were established; 107 farmers increased their business, 55 increased production and 135 adopted new marketing strategies. Furthermore, 5 farmers reported introducing new agricultural products to the market; 5 new agreements between farmers and members of the distribution chain were established, 15 agribusinesses increased their production and 15 new agribusinesses were established.</p> <p>External Factors (optional) Earthquakes in southwest Puerto Rico and the COVID-19 pandemic caused a reduction in the farm labor force.</p> <p>Other information such as relevant websites is optional. Publications about financial planification for farmers: Comas, M. (2018). Planificando Mi Finca. UPRM SEA MEI Web Page to assists farmers develop their business plans: Educación en Mercadeo Agrícola (mercadeoagricolapr.com) Online Platform to learn about Marketing studies: Myrna Comas Pagán</p>	
5.	Home, School and Community Gardens	<p>What is the issue? Puerto Rico has a highly vulnerable food supply chain; the number of farms decreased by 38% between 2012 and 2018 and the Island is a net food importer. Puerto Ricans need to find sustainable and practical ways to produce food to reduce food vulnerability. Learning how to produce food at home, in schools and communities seems to be a logical approach to developing a culture of sustainability and local food production.</p>	Food Security, Plant & Animal Systems

		<p>Target audience Housewives, students, teachers, and the general public benefited from these activities, learning how and what food crops to grow in their communities.</p> <p>What has been done? PRAES personnel provided individual assistance and training in crop gardens to 15,007 people. To provide follow up training and market the project, two electronic pages were developed: PR Composting” (a YouTube channel in collaboration with PRAEX and PRAES personnel), and “Urban Agriculture UPRM”. The project also has a group of 148 volunteers, including participants of the Master Gardener program. In collaboration, these teams achieved 851 volunteer hours of work. As part of these initiatives, 45 teachers from the Educational Department were trained in setting up school food gardens: https://business.facebook.com/509700236085642/posts/1177903249265334/ https://business.facebook.com/sea.uprm/videos/424059894859059/</p> <p>Results As a result of this project, 251 home gardens, 19 school gardens and 15 community gardens were established.</p> <p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. CompostaPR https://www.youtube.com/user/compostapr Agricultura Urbana UPRM https://www.uprm.edu/agriculturaurbana/inicio/ Publications Comas, M. (2020), Caja de Herramientas de Agricultura Urbana. UPRM SEA MEI.</p>	
6.			

	<p>Citrus Germplasm testing to Improve Citrus Production.</p>	<p>What is the issue? Puerto Rico's citrus growers rely on the PRAEXS for the production and maintenance of disease-free citrus varieties. To secure the availability of disease-tested <i>Citrus</i> spp. at the experiment stations, the foundation blocks and citrus germplasm collection are tested regularly for systemic pathogens. In collaboration with the Department of Agriculture of Puerto Rico, plants from private nurseries are also tested for HLB (citrus greening) and Citrus Tristeza Virus (CTV).</p> <p>Target audience Citrus growers, nurseries, and the general public that benefited from the development of citrus greening-free citrus varieties.</p> <p>What has been done?</p> <p>PRAEXS has continued with the certification program for citrus propagative material from commercial nurseries. With the support of our Hatch program and the Citrus Clean Plant Network (CCPN), citrus varieties and mother plants from PRAEXS nurseries at Isabela and Adjuntas Substations, and from four private nurseries, were tested for systemic pathogens.</p> <p>The nurseries of the Adjuntas and Isabela Substations were renewed leading to the restoration of the production of <i>Citrus</i> spp. mother plants. The certification of <i>Citrus</i> spp. in four commercial nurseries “El Eucalipto”, “La Plata”, “Hacienda Ramirez” and Citrus Inc. was accomplished securing the availability of more than 36,000 citrus plants for orchards on the island.</p> <p>In a virtual meeting via google we met with citrus nursery producers and personnel from the Department of Agriculture of Puerto Rico on December 17, 2020 to discuss protocols for citrus sampling, surveillance using sticky traps and future directions.</p> <p>Results</p>	<p>Food Security, Plant & Animal Systems</p>
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		<p>The collection of 27 <i>Citrus sinensis</i> commercial varieties in Isabela, and 210 mother plants in Adjuntas tested free of <i>Candidatus Liberibacter asiaticus</i> HLB and CTV. <i>Citrus</i> spp. plants were grown in screen-protected structures of private nurseries “El Eucalipto” in Las Marias. Citrus Inc. in Utuado, “Finca La Plata” in Sabana Grande and “Ramirez nursery” in Lares tested free of HLB and CTV. In “El Eucalipto” and “La Plata”, 100,000 and 70,000 citrus plants were produced from ‘Valencia’ grafted on ‘Swingle’ and ‘Brazilian Sour’, respectively. Other varieties tested in “La Plata” were: Variegada, Fronton and Lisonja. Two percent of 20,000 plants were tested for HLB and CTV. These nurseries are producing ‘Cleopatra’/‘Valencia’ and ‘Cleopatra’/‘Tahiti’ under screen-protected structures.</p> <p>In Adjuntas and Isabela Substations, renewal of the mother plants is underway for ‘Tahiti’, ‘Meyer’, ‘Giant Key Lime’, ‘Mexican’, ‘Variegado’, ‘Valencia Campbell’, ‘Valencia late’, ‘Road Red Valencia’, ‘Washington Navel’, ‘Cara-Cara’ and ‘Tangelo’, grafted in ‘Swingle’ and HRS-812 for a total of 236 plants.</p> <p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. N/A</p>	
7.	Plant Diagnostic Clinics	<p>What is the issue? Prevention of pests and disease outbreaks requires a reliable resource for fast and accurate disease and pest identification.</p> <p>Target audience Growers, researchers, extension agents, seed companies, and the general public have been trained in identification and prevention of diseases in plants and received plant diseases diagnostics.</p> <p>What has been done?</p>	Food Security, Plant & Animal Systems

		<p>The Puerto Rico Plant Disease Diagnostic Clinic (PRPDDC) at PRAEXS-Juana Diaz received accreditation from the National Plant Diagnostic Network (NPDN) for a five-year period starting May 1, 2020. During the fiscal year, the PRPDC continued to provide fast and accurate diagnostic service for more than 600 plant samples using standard, serological and molecular methods. Corn, soybeans, sunflower, cotton, and cereals grown in the winter nurseries were tested for ten different quarantine pathogens. Also, the National Plant Diagnostic Network conducted a workshop for 12 diagnosticians of the U.S. Plant Diagnostic Clinics at the Juana Diaz facilities.</p> <p>The other two clinics of the PRPDDC, located in the western and northern regions, received 96 plant samples from growers and each sample results included recommendations from specialists. This clinic also provides follow-up through social media blog posts, https://www.facebook.com/clinicauprm/, reaching up to 6,000 users per post.</p> <p>Results New diseases were identified in <i>Annanas comosus</i> – <i>Marasmiellus palmivorus</i>, <i>Pleospora</i> sp. in <i>Allium cepa</i>; Jathropha mosaic virus - <i>Gossypium hirsutum</i>; <i>Phoma</i> sp. in <i>Asparagus setaceus</i>; <i>Botrytis cinerea</i> affecting <i>Lactuca sativa</i> and <i>Fusarium semitectum</i> in <i>Oryza sativa</i>; all were first reports for Puerto Rico.</p> <p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. N/A</p>	
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<p>8.</p>	<p>Improving the Quality of Puerto Rican Coffee</p>	<p>What is the issue? Hurricane Maria destroyed 90 percent of coffee trees on the island. Most small-scale specialty coffee farmers lost their entire business operations. The local government, Starbucks and other organizations made donations of new varieties. To revitalize the quality of the coffee, these varieties must be grown using the best practices.</p> <p>Target audience. Coffee growers and nurseries who will benefit by learning recommended practices for producing healthy seedlings. Coffee consumers and PRAES County Agents learned how to test and identify the different categories and characteristics of quality coffee.</p> <p>What has been done? Extension specialists and agents from PRAES worked on an initiative in collaboration with the Department of Agriculture of Puerto Rico (DAPR) where they trained agronomists from the DAPR and coffee growers to grow new resistant varieties donated by Starbucks, and other local organizations. The workshops were given to local farmers from 5 municipalities in the island's central region to adopt the varieties 'Limani', 'Fronton' and 'Marsellesa' used to improve the quality of coffee grains in Puerto Rico.</p> <p>Results. As a result of this initiative 163 growers received face-to-face and virtual training, and 11 growers improved the quality of coffee on their farms. In addition, the PRAES coffee team of experts reported that 276 participants developed skills to identify coffee quality parameters, which led to identifying 16 producers able to participate in the 5th Gold Quality Competition of Coffee held virtually. This competition selected 24 coffee samples from previously grown improved coffee grains; 67% of these were categorized as Special (over 80 points in quality), and 33% were graded Premium (70 points in quality).</p> <p>Other information such as relevant websites is optional. Coffee quality competition; The Golden Cup of Puerto Rico</p>	<p>Food Security, Plant & Animal Systems</p>
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		<p>https://youtu.be/tgNfwK4skVc Coffee Tasting</p> <p>https://youtu.be/jxoPd3brGzs Nutritional Value of coffee and methods for its extraction</p> <p>https://youtu.be/2_9prZ22mMc Success stories of the Cafetaleros of PRAES</p> <p>https://youtu.be/R7Vg-Kr3HWw</p>	
9.	Genetic and management strategies to reduce the effects of heat stress in cattle	<p>What is the issue? Heat stress continues to be the biggest challenge to the Puerto Rico Dairy and Beef Industry. Not only does it compromise the welfare of susceptible bovines, but the physiological implications drastically reduce efficiency of production. A slick hair gene appears to enable cattle to adapt to heat stress. Improving knowledge of the Puerto Rican slick-haired cattle and those management practices that help reduce the effect of heat stress are imperative to increase efficiency of milk and meat production on dairy and beef farms.</p> <p>Target audience Dairy and beef farmers who benefited by learning how the slick gene and management practices can help their animals to better cope with heat stress</p> <p>What has been done? Several studies were conducted to better understand the benefits of the slick gene in terms of growth patterns, eating behavior and health by comparing these parameters between slick-haired and non-slick Puerto Rican Holstein calves and heifers. Other studies assessed the effects of an accelerated growth feeding protocol on weight gain and future milk yield in slick and wild-type Holsteins calves. A parallel project is implementing novel reproductive biotechnologies and genomics to reproduce and commercialize genetically superior slick dairy and beef cattle. Results generated by these and previous studies on slick cows and heat stress have been disseminated through short online presentations (n=2) and farm visits (n=12) to train farmers about how to reduce the effects of heat stress on their animals.</p>	Food Security, Plant & Animal Systems

		<p>Results</p> <p>Although slick Holstein cows have demonstrated superior reproductive and productive performance over contemporary non-slick cows, calves grew at the same rate regardless of the genotype and the feeding protocols (traditional or accelerated). With the data generated by these studies, abstracts were presented at the annual meeting of the Animal Dairy Science Association (n=3) and at the annual meeting of the American Society of Animal Science (n=2). One peer reviewed journal article was published: <i>J. Agric. Univ. P.R. 104(1):31-42.2020</i> https://doi.org/10.46429/jaupr.v104i1.18286. A total of 7 farmers adopted recommended practices to overcome the effects of heat stress. Among these were the use of semen from slick bulls (Simba; homozygous slick bull from Puerto Rico) and the construction of structures to provide shade to calves. Through the online presentations, a total of 9,070 people were reached and 337 engaged.</p> <p>External Factors (optional)</p> <p>Due to the earthquakes and COVID-19 biosecurity protocols, many research trials have been delayed.</p> <p>Other information such as relevant websites is optional.</p> <p>https://www.facebook.com/sea.uprm/videos/332600694352387 https://www.facebook.com/watch/?v=2491110024329265</p>	
10.	Intensive training for intensive changes: The calf education program	<p>What is the issue?</p> <p>Puerto Rico's dairy industry is the island's most important agricultural enterprise. Not only does it provide more than 15,000 jobs and over \$500M yearly, but it also justifies the presence of animal food mills, favoring feed concentrate accessibility to other local livestock producers. However, the dairy industry confronts several challenges such as heat stress, elevated production costs, tropical diseases, and poor management practices. Among the latter, proper calf care is one of the most important aspects of a</p>	Food Security, Plant & Animal Systems

dairy farm required to achieve optimal yields in dairy cattle. Nevertheless, farmers in Puerto Rico do not completely understand the significance of appropriate calf care.

Target audience

Dairy farmers and PRAES personnel working with dairy cattle will benefit by increasing their knowledge about best practices to raise healthy calves.

What has been done?

A special educational program was developed to train Extension Agents (n=11) intensively in tools to measure important health parameters in dairy calves. These included immunoglobulins in blood and colostrum, dehydration status, size, weight, body condition score and awareness (as an indicator of health). Additional training involved, nutrition and growth, health, physiology of mammary development and disease in dairy calves. Demonstrations were performed using calf pens from a Hatch project (H-471) at the Gurabo Substation. All the practical training was done with these animals. A webinar about the benefits and successes of this project was presented on the official Extension Facebook page to promote the project to other dairy farmers. Educational videos (n=4) about best practices for dehorning, identification, colostrum management, and preventing navel infections in calves were produced and posted on YouTube to show farmers how to execute best practices on calves.

Results

Four Extension Agents participated in the program providing intensive training to 15 dairy farmers. Educational activities, data collection and follow-up visits were performed for 3 years. The most important achievements included:

A total of 158 calf pens were upgraded from 8 ft² to a 20 ft² area (25 were expanded by merging 2 pens and 133 were bought or constructed).

Two farmers bought a milk pasteurizer to pasteurize waste milk fed to calves (previously calves were fed unpasteurized waste milk)

Two farmers increased frequency of milk feeding (once vs. twice daily)

One farmer reported reducing mortality in calves (from 15% to 5.0 %).

		<p>The feedback generated by participating dairy farmers has increased the interest of other dairy farmers to participate in this intensive educational program. In addition, several dairy farmers have solicited federal and local ag-related agencies (ReGrowth and Department of Agriculture of Puerto Rico) to include calf pens in their incentives. A total of 12,573 people were reached and 579 engaged through the Facebook webinar and 268 views on YouTube.</p> <p>External Factors (optional)</p> <p>Other information such as relevant websites is optional.</p> <p>Presenting the Calf Care Program to Dairy Farmers https://www.facebook.com/watch/live/?v=261830885073864&ref=watch_permalink</p> <p>Best practices for dehorning calves https://www.youtube.com/watch?v=5n7lcyVfVMo&t=79s</p> <p>Identification in Calves https://www.youtube.com/watch?v=i9b3Ubk67Dg&t=2s</p> <p>Colostrum management https://www.youtube.com/watch?v=J2T08D-vL_U&t=347s</p> <p>Preventing navel infections in calves https://www.youtube.com/watch?v=qXOKf61xvV4&t=25s</p>	
11.	Beef cattle and small ruminants as a strategy to increase local food security	<p>What is the issue?</p> <p>The meat industry of Puerto Rico continues to decline, producing less than 10% of local demand. Costs of production, poor nutritional management, and disadvantageous treatment, with respect to meat importers, are some of the main challenges that local producers face. A similar scenario occurs with dairy goat producers. Studies to determine the marketing strategies, best management and nutritional practices and the development of new value-added products represent alternatives for beef and lamb producers and dairy goat producers to increase the availability of local food for human consumption.</p> <p>Target audience</p>	Food Security, Plant & Animal Systems

Beef cattle producers, members of the local Cattlemen Association, Beef Cattle Production Fund, Beef Producers Cooperatives, PRAEXS, PRAES personnel working with meat producers, Members of the Department of Agriculture of Puerto Rico Small Ruminant Production Fund, and independent sheep and goat producers will benefit with the research findings and training provided by PRAEXS and PRAES personnel.

What has been done?

Studies on the effect of sex, nutritional plane, and processing age on the growth efficiency, carcass composition, beef quality and economic returns of grazing Senepol calves are being conducted.

Growth, carcass characteristics, meat quality and fatty acid profile of lambs raised grazing native tropical pastures or fed with total rations have been evaluated.

Reproduction trials to evaluate ram semen quality of *Criollo x Dorper* and *Criollo x Katahdin* rams have been conducted.

A survey on the characteristics of the potential consumer for goat milk products was conducted. Preliminary elaboration of confections using goat milk are in progress. A total of 4 trainings were provided to goat farmers

Several webinars were presented that provided information regarding goat breeds adapted to insular areas, recommendations for optimal goat farming, goat milk characteristics, cheese elaboration and control of internal and external parasites in goats.

Another webinar was offered to high school students to encourage early engagement in goat farming.

Results

Field research trials have preliminarily shown that the use of creep-feeding type supplementation enhanced the growth of pre-weaning beef calves, and that the growth of intact males was higher than castrated ones.

Feeding system affected performance, carcass yield and meat quality of lambs raised under heat stress conditions. Sexual maturity based on sperm concentration of criollo x dorper and criollo x katahdin rams was reached at 10-11 months.

		<p>Survey on goat milk (n = 649) showed 58% of respondents are consumers of goat milk products; 65% indicated they would purchase goat milk cheese manufactured in Puerto Rico if it were available; 57% would purchase confections and 58%, yogurt. Forty-two percent are non-consumers of goat milk products mainly because they have never tried goat milk products (46%), due to lack of availability of such products in the retail market. A thesis publication was generated with these studies (Rios-Lugardo, Andrea. 2020) and two peer-reviewed journal publications were published: J. Agric. Univ. P.R. 104(2):181-199 and J. Agric. Univ. P.R. 104(2):201-221. A total of 17,481 people were reached through the webinars and 565 were engaged. Follow-up visits are being scheduled to determine the incorporation of practices by the webinar participants.</p> <p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. Thesis Publication https://scholar.uprm.edu/bitstream/handle/20.500.11801/2621/CIAN_RiosLugardoAP2020%20.pdf?sequence=3&isAllow</p>	
12.	Natural resource protection amid extreme weather and natural disasters	<p>What is the issue? There is a need to improve agricultural resilience and natural resource protection with the increased climate variability and extreme weather that Puerto Rico has been experiencing.</p> <p>Target audience Community leaders, community members, farmers, producers, government officials, Extension personnel, Department of Agriculture of Puerto Rico personnel, and 4-H youth groups will benefit from the conservation practices provided in this program.</p> <p>What has been done?</p>	Extreme Weather, Environment & Sustainable Energy

Educational efforts with USDA/NRCS focused on soil erosion control to increase awareness of soil protection. These included training workshops on watershed protection, water harvesting and storage.

Assistance was provided to farmers in connection with natural disaster recuperation efforts. This work was published at SEA del OESTE to allow other farmers to learn from these experiences. Additional, Extension publications on climate change mitigation and natural resource protection were published to benefit farmers. These included: Climate Change and Soil, Brush and Forest Fires in Puerto Rico, Recycling: The Best Alternative, The Recycling Situation in Puerto Rico, Climate Change Progress and Agriculture Production, and Climate Change: Agronomic Approaches and Recommended Practices Through History (see Results).

Workshops in collaboration with the Caribbean Climate Hub were given in several municipalities across the island. The workshop was titled "Tools for agricultural resilience" and focused on developments in tropical agriculture under drought conditions.

Results

A total of 216 individuals received capacity development in soil erosion, watershed protection, water quality, and storm water runoff control.

Twelve individuals received capacity development in loss mitigation due to natural disasters and emergency management.

Seventy individuals participated in non-formal educational courses on water collection, storage, and reuse for agricultural purposes.

These efforts have led to the adoption of more than 70 recommended practices for the mitigation of climate change or extreme weather events (water use efficiency, waste management, livestock feeding practices, carbon sequestration, etc.) on their farms.

Selected Extension publications include:

1. Bair, Daniel A. 2019. Uniendo Esfuerzos. SEA del Oeste. Agricultural Extension Service, University of Puerto Rico.

2. Bair, Daniel A., et al. 2020. Impact of biochar on plant growth and uptake of ciprofloxacin, triclocarban and triclosan from biosolids. J of Env Sci and Health, Part B; V 55:11, p 990-1001.
3. González Toro, Carmen. 2019. Reciclaje: La mejor alternativa. SEA del Oeste, Agricultural Extension Service, University of Puerto Rico.
4. González Toro, Carmen. 2019. La situación del reciclaje en Puerto Rico. SEA del Oeste, Agricultural Extension Service, University of Puerto Rico.
5. González Toro, Carmen. 2019. Antecedentes al cambio climático: Modalidades o enfoques agronómicos y sus prácticas a través de la historia. SEA del Oeste, Agricultural Extension Service, University of Puerto Rico.
6. González Toro, Carmen. 2019. El avance del cambio climático y la producción agrícola. SEA del Oeste. Agricultural Extension Service, University of Puerto Rico
7. Rodríguez Cruz, Luis Alexis and Niles, Meredith T. 2019 El impacto del huracán Maria en el sector agrícola puertorriqueño. SEA del Oeste. Agricultural Extension Service, University of Puerto Rico.

A podcast was broadcast to show farmers the significance of agriculture in Puerto Rico with a reach of 2,011 people and 119 engagements:

Soto Torres, Giovannie. 2020. La importancia de la Agricultura con el Dr. Giovannie Soto Torres. Un ratito Con Win (Edwin Marrero).

External Factors (optional)

N/A

Other information such as relevant websites is optional.

SEA del Oeste

<https://www.uprm.edu/sea/sea-del-oeste/>

Podcast Link:

<https://anchor.fm/edwin-marrero3/episodes/La-importancia-de-la-Agricultura-con-el-Dr-Giovannie-Soto-Torres-ebujt8/a-a3rd0ov>

<p>13.</p>	<p>Soil quality assessment among soil orders and ecological zones in Puerto Rico</p>	<p>What is the issue? Soil quality assessment is an important aspect for extreme weather adaptation. It requires the identification of a set of sensitive attributes that reflect the capacity of soil to function efficiently within land use and ecosystem boundaries. The diversity of soils and agricultural commodities in Puerto Rico presents a major challenge when determining the quality of agricultural soils. A poor-quality soil for one agricultural commodity is not necessarily of poor quality for another commodity. A major objective is to create a soil data bank that will facilitate soil management and use, preserving soil quality and health. Educational and outreach activities were held to promote public awareness of soil quality and health, soil conservation, preservation, and management.</p> <p>Target audience Land managers, farmers, community leaders, government officials, undergraduate and graduate students from the College of Agricultural Sciences, agronomists from the Department of Agriculture of Puerto Rico, PRAEX and PRAES personnel and general public will learn about soil health parameters and relevance of monitoring these to optimize crop production.</p> <p>What has been done? During the past year, soils intensively managed and under natural conditions from the Coto, Cotito and Corozal soil series were analyzed for enzymatic activity (phosphatase, urease, and dehydrogenase). Soils from the Corozal and Dagüey series were evaluated for soil density, texture, pH, organic matter content, and available phosphorus content. At the PRAEXS Isabela Substation in northwestern Puerto Rico, soil quality parameters of Cotito clay (Lithic Kandiodox) were also evaluated. On December 5, 2020, Arte-Suelo-Ser, a student-organized virtual conference on soil, was held to share the results from this project in addition to other soil related presentations. The full-day conference (9am-5pm) was comprised of 23 presentations from experts in fields relating to soil that covered the management, use and stewardship of soil resources.</p>	<p>Extreme Weather, Environment & Sustainable Energy</p>
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		<p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. <u>Arte Suelo Ser</u> https://www.facebook.com/artesueloser.pr/ https://www.instagram.com/arte.suelo.ser/</p>	
14.	Sustainable pig production in Puerto Rico	<p>What is the issue? High energy costs and high risk of environmental pollution threaten the disappearance of small and mid-sized pig farms. An alternative to overcome this threat includes the generation of energy from methane.</p> <p>Target audience Swine producers in the central region of Puerto Rico and small and medium sized energy enterprises interested in the use of manure as a source of energy and nutrients. They will learn the procedures and technology to determine if the generation of biofuels is applicable to their swine farms.</p> <p>What has been done? The biochemical methane potential (BMP) of swine manure was determined and organic sources such as potato and plantain waste were used to increase C/N ratio. The results of BMP were used to complete the design of the co-digestor.</p> <p>Results The design of a co-digestion anaerobic reactor with 85 m³ volume has been completed. Students from the College of Agricultural Sciences have been working alongside students from the Electrical Engineering Department to optimize the design (software and electronic circuit boards) to expand the capability of the BMP setup.</p> <p>External Factors (optional)</p>	Extreme Weather, Environment & Sustainable Energy

		<p>The earthquakes that affected the island at the beginning of 2020 and the lockdown caused by COVID-19 has delayed the completion of all the projects objectives.</p> <p>Other information such as relevant websites is optional. N/A</p>	
15.	Innovation for a sustainable forestry industry	<p>What is the issue? After Hurricane Maria, we were confronted with the difficult task of disposing of the organic vegetative material, fallen trees, in particular. Moreover, research was needed on developing forest products from the most abundant tree species in the novel forests of Puerto Rico.</p> <p>Target audience Agricultural Extension agents, scientists and entrepreneurs interested in starting a business in forestry or forestry products.</p> <p>What has been done? We used different invasive species to produce biochar. A preliminary greenhouse experiment was established to evaluate the effect of mixtures of white siris biochar with promix on basil (<i>Ocimum basilicum</i>) growth.</p> <p>Workshop: Safe use of a chainsaw in previous situation and after a hurricane. September 3-5, 2019. In collaboration with the Caribbean Climate Hub of the USDA-Forest Service.</p> <p>Outreach publications: Robles, W. 2019. Del árbol caído no necesariamente todos hacen leña. SEA de Oeste num. 3 2019.</p> <p>Ruiz, A. 2019. Educando para conservar y maximizar el uso de recursos madereros de PR. SEA del OESTE num. 3 2019.</p>	Extreme Weather, Environment & Sustainable Energy

		<p>Rivera Ocasio, D. 2020. Nuevo Proyecto emblemático de madera en la Subestación Experimental Agrícola de Corozal.</p> <p>Results Air dried biochar from <i>Albizia procera</i> had humidity of 50% and yielded between 10-20%. The determination of humidity and biochar yield for Honduras pine (<i>Pinus caribaea</i>) and African tulipan (<i>Spathodea campanulata</i>) is in progress. Basil growth was similar in all biochar/promix mixture.</p> <p>External Factors (optional) Lockdown due to COVID-19 has delayed field and laboratory work.</p> <p>Other information such as relevant websites is optional. A Facebook page was built to include information about ongoing progress of research and outreach information: https://www.facebook.com/labforestal A project-associated website underscoring activities and objectives was created in: sites.google.com/upr.edu/laboratorioforestal/principal</p>	
16.	Wild beehives as an assessment of melliferous plant, bee and honey quality	<p>What is the issue? The disruption of bee natural habitats either because of intense agricultural practices or natural disasters have pushed wild and honeybees into worldwide decline. Hurricane Maria had a devastating effect on beehives around the island.</p> <p>Target audience Beekeepers, agricultural extension and state agents, faculty, honey related business.</p> <p>What has been done? Field data related to melliferous plants, bee genetics and beehive pests have been collected. Artificial diets for <i>G. mellonella</i> rearing were developed and successfully</p>	Extreme Weather, Environment & Sustainable Energy

		<p>tested. Pollen collectors were installed at the beehives and they are currently collecting pollen.</p> <p>Andrés Cursio. 2019. Melliferous plants identification and laboratory techniques for pollen extraction – Webinar type presentation provided to undergraduate students at the University of Puerto Rico, Mayagüez.</p> <p>Worshops (Manrique Planell, Extension Agent) Cleaning and maintenance of the beehive How to use sugar substitute source to feed the colony Pollen collection and traps installation on the beehives Swarming prevention techniques Wax foundation frame mounting techniques, and labeling the queen for monitoring</p> <p>Results Six of the Agricultural Experiment Substations have successfully established beehives on their grounds. Both, <i>G. mellonella</i> and <i>A. grisella</i> have been collected as larvae and raised in the laboratory on artificial diets. Emerged adults have been mounted and properly labeled as voucher specimens for further reference. Phenotypic differences have been observed, such as bee size and color. These traits are considered genetic variations of bee milotypes.</p> <p>External Factors (optional) Lockdown due to COVID-19 has delayed some of the field and laboratory work.</p> <p>Other information such as relevant websites is optional. N/A</p>	
17.	Elaboration of flour and extruded <i>apio</i> products	<p>What is the issue? <i>Arracacia</i>, commonly known as celeriac or <i>apio</i>, is a specialty crop grown by many upland small farmers in Puerto Rico. Processing flour from <i>apio</i> (<i>Arracacia xanthorrhiza</i>) is a promising post-harvest preservation strategy for this crop. Puerto Rico's farinaceous</p>	Food Safety & Science Technology

	<p>(Arracacia xanthorrhiza Bancroft) as an alternative for the use and commercialization of this crop</p>	<p>crops have great quality and potential for establishing a value-added industry. To achieve this goal studies are needed on the crop's processing characteristics and new products need to be formulated with qualities that satisfy consumer's tastes and preferences.</p> <p>Target audience Scientists in the public sector working with technology for processed vegetables and root crops growers will gain additional strategies for post-harvest preservation of celeriac.</p> <p>What has been done? Physicochemical and functional properties of apio starch prepared from the storage root, the rootstock and stems were investigated. The gelatinization behavior of starch granules was also examined using differential scanning calorimetry (DSC). A preliminary experiment formulating extruded products was conducted to examine three variables: flour moisture, temperature, and screw size.</p> <p>Results Significant differences in physicochemical and functional properties of apio were observed ($P < 0.05$). The size of starch granules was determined to be between 5 μm to 15 μm for storage root, 3 μm to 10 μm for rootstock, and 4 μm to 10 μm for stems. Most of the Arracacia starch granules are irregular in shape. DSC-results of three starch samples showed that 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 as a low GI food and a good dietary carbohydrate alternative for diabetic people. Extruded products experiments are still ongoing with changes in the extrusion parameters.</p> <p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. N/A</p>	
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18.	Value added products from plantains	<p>What is the issue? The Puerto Rico Agricultural Experiment Station (PRAEXS) successfully introduced the Maiden plantain hybrid to the island. Current data show improved yields of Maiden over the commercial favorite, Maricongo. The main goal is to gather data on Maiden's potential to develop value-added products compared to Maricongo, and to provide prospective processing industries information on the processing characteristics of Maiden plantains.</p> <p>Target audience Plantain growers and food industry representatives who benefited from the findings generated through this study which made available new cultivar alternatives to increase plantain yields.</p> <p>What has been done? Studies of the Maricongo, Maiden and FHIA 20 plantain cultivars that included proximal analysis, starch digestibility properties, expected glycemic index and starch granule characteristics were conducted.</p> <p>Results: Proximal analysis results showed similarities between Maiden and Maricongo cultivars. However, FHIA 20 proximal analysis results differed from Maiden and Maricongo. According to the starch digestibility properties and expected glycemic index, the eGI values were similar between the varieties within the same cooking process. Baking is a good alternative cooking method, since it presented properties that reflect a lower glycemic impact and, therefore, constitutes a healthier option to include in the diet. The results showed the Maiden variety is a potential option to replace Maricongo and could be successfully commercialized, helping to reduce plantain imports.</p> <p>External Factors (optional) N/A</p>	Food Safety & Science Technology
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		<p>Other information such as relevant websites is optional.</p> <p>N/A</p>	
19.	Preventing foodborne illness dissemination through education and certifications	<p>What is the issue?</p> <p>Consumers do not recognize their homes as a place in which they could get a foodborne illness. Safe handling practices are necessary to reduce dissemination of foodborne illness, not only in their homes but at food establishments. The Puerto Rico Health Department adopted Food Code in 2000, requiring all persons in charge of a food establishment to approve a certified food safety course. In this regard, educational programs that increase knowledge and awareness of the relevance of implementing recommended food safety practices should be considered as an important strategy to reduce the risk of foodborne diseases.</p> <p>Target audience</p> <p>General public, at-risk population, and people in charge of retail food establishments who have learned the significance of implementing recommended food safety practices to reduce foodborne diseases within their families and among clients. The latter consider implementation an important strategy to maintain their food establishment's good reputation.</p> <p>What has been done?</p> <p>PRAES Family and Consumer Science Educators offered 142 non-formal food safety courses to retail food establishment owners, with 733 employees and owners completing the courses.</p> <p>Also, 1,157 consumers participated in non-formal education courses related to food safety preparation.</p> <p>A total of 1,008 Food Safety Manager's courses and exams from the National Registry for Food Safety Professionals (NRFSP) was provided to Food Managers/Owners. The Food Safety Course includes all the topics required by the Food Code such as employee health, cleaning and sanitizing, and cooking temperatures, among others.</p>	Food Safety & Science Technology

Results

Thirty-three volunteers collaborated on the safety course dedicating a total of 152 hours of service.

A total of 394 consumers reported adopting at least one recommended practice to preserve food: 52 preserved food through home canning, 111 through dehydration and 107 through Mylar bags with oxygen absorbers. In addition, 71 participants prepared a HACCP plan with the technical assistance of an Extension educator and 84 implemented the HACCP plan in their food establishments

Of those who took the Food Managers course, 806 passed the food safety test certification. These managers are now in compliance with the Food Code of 2017 and were able to obtain or renew the permits to operate their food establishments. From the total participants, 712 managers reported adopting at least 3 safe handling practices. These practices included: implementation of minimum cooking temperatures, appropriate hand washing, employee health and hygiene, Standard Operational Procedure (SOP) for the appropriate management of human fluids such as vomit and feces, avoidance of food-to-food cross contamination, proper general cleaning and sanitizing for food establishments, among others.

During the shutdown caused by COVID-19 many people lost their jobs and needed to look for ways to earn income. Thanks to the help and training from one of our Consumer Science Educators on food safety and how to establish a food establishment, one participant was able to establish her own business. She began with an initial investment of \$500.

External Factors (optional)

COVID-19 has impacted the way we used to offer the Food Safety Courses to food managers. Puerto Rico was shut down for nearly 5 months, during which we could not offer any Food Manager Courses. Even when we were able to begin to offer courses, protocols require physical distancing. Although we offered some courses online, many

		<p>food managers preferred face-to-face interactions. The exams were offered in a classroom with small groups, so the courses had to be offered more frequently. In addition, parts of the southern area of the island were still struggling with the aftermath of earthquakes that began in December 2019. Some of the building structures where we had offered courses suffered damage and were shut down by authorities due to safety concerns.</p>	
<p>20.</p>	<p>Facing adversity through community economic development, disaster management, and volunteer training programs</p>	<p>What is the issue? The economy of Puerto Rico, still affected by the impacts of natural disasters (2017 hurricanes, early 2020 earthquakes), was practically paralyzed from March to July 2020 because of the COVID-19 pandemic. Communities urgently needed to identify opportunities to develop family and community enterprises that could generate income and improve their quality of life. Volunteer leaders needed to quickly update their organizational, technology and business skills in order to meet new challenges, including the possibility of other emergencies in the midst of the pandemic.</p> <p>Target audience Disadvantaged and rural communities; volunteer community leaders and general public.</p> <p>What has been done? 1. PRAES started a series of three educational campaigns (https://www.uprm.edu/sea/extension-virtual/) to train trainers in using technology while presenting project achievements to the general public. Over 2,000 participants and 20,000 viewers have accessed these campaigns. 2. Trained leaders to work with food preparation, textiles, designing and sewing new products. Community leaders gained the skills to develop and market clothing, handcrafts, and masks during the pandemic (e.g., https://www.facebook.com/Creaciones-Mldy-104800497914318/). NGOs and government institutions collaborated with PRAES and community leaders to develop their projects.</p>	<p>Community, Economy and Sustainable Development</p>

		<p>3. Continued to train leaders in disaster management and in the development of emergency plans; 185 community leaders were trained on these topics.</p> <p>Results</p> <p>1. One hundred trained volunteers helped to train the program's clientele. Six new community gardens were developed by community leaders and volunteers, and 32 community projects were organized; 1,493 volunteer hours were logged working and training volunteers in community gardens, NGO stores and the local food bank. PRAES staff participated in radio programs and live streaming training on social media.</p> <p>2. The community self-management approach allowed community entrepreneurs to maintain or improve their income by more than <u>thirty-nine thousand dollars (>\$39K)</u>, to shorten the recovery response period and better prepare people to handle an emergency. Five new economic projects were developed, 61 participants received economic benefits and 14 new employment opportunities were created, developing 49 new alliances to strengthen community initiatives. A small family business was opened to elaborate “sofrito”, a blend of vegetables and herbs at the base of many Puerto Rican dishes, with nine community gardens sponsors.</p> <p>3. One hundred twenty-six families developed emergency plans and three community plans. PRAES and volunteer leaders, along with NGOs, delivered food and essential items to disadvantaged communities after the earthquakes and during the COVID-19 pandemic lockdown.</p> <p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. N/A</p>	
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<p>21.</p>	<p>Consumers of differentiated coffees are willing to pay more than twice the price of regular coffee in Puerto Rico</p>	<p>What is the issue? Puerto Rican coffee growers keep registering reduced profits due to increases in production costs and the introduction of new diseases. Studies performed by the PRAEXS during the last decade suggest that differentiated coffees can potentially attract high-income market segments and increase farmers' profits. Yet, to devise better market strategies for regular coffee and differentiated coffee in Puerto Rico, data is still needed on the characteristics of different market segments, market size and locations, and consumer profiles and preferences. A study addressing some of these information gaps was conducted in six municipalities of the island.</p> <p>Target audience Coffee industry components: growers, processors, roasters, marketers, baristas, and coffee shop owners; policy makers, government and NGOs related to the coffee industry; professionals, researchers, and extension service agents.</p> <p>What has been done? 1. A survey of retail food stores was performed to identify and characterize the supply of coffee and non-alcoholic substitute beverages at select municipalities in different regions of Puerto Rico (N=458). Another survey was designed and distributed to consumers of differentiated coffees at coffee shops (N=580). 2. Estimates of the elasticity of demand for coffees of regular (undifferentiated), differentiated, and differentiated by Puerto Rico origin were performed. Cross price elasticities for nonalcoholic beverages (milk and juice) were also estimated. 3. Two presentations were offered at annual meetings and forums organized by the PRAEX in collaboration with PRAES. These meetings were oriented to coffee sector stakeholders, including government officials. Two refereed articles are being reviewed for publication.</p> <p>Results</p>	<p>Community Economy for Sustainable Development</p>
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		<p>Results from the survey of food retail stores showed that coffee consumers in Puerto Rico are predominantly urban, 54% female, and 71% with an annual income of less than \$50,000. They buy coffee in supermarkets, pay an average of \$5.78/lb (\$3.40-\$15.40/lb), and consume 12.7 lb per capita annually. Demand estimations suggest that both differentiated, differentiated by Puerto Rico origin, and regular coffees are inelastic and a normal good. The estimation suggests non substitution, or a complementary relationship among the coffees and nonalcoholic beverages studied. In the retail sample the average price per ounce of roasted regular coffee was \$0.37. In the coffee shop sample, the average price per ounce of roasted coffee was \$0.541 for regular; \$1.216 for differentiated; and \$1.179 for differentiated by Puerto Rico origin. Consumers of differentiated and differentiated by Puerto Rico origin coffees are, therefore, willing to pay more than twice the price of regular coffee for differentiated coffees. Coffee producers, roasters, and marketers could use these results to forecast demand reaction to changes in prices for regular and differentiated coffees. Public policy makers could also use these results to design and implement commodity programs and policies that promote differentiated coffee.</p> <p>External Factors (optional) N/A</p> <p>Other information such as relevant websites is optional. N/A</p>	
22.	Health promotion and disease prevention for the elderly and caregivers	<p>What is the issue? The current COVID-19 pandemic impacts the lives and well-being of our populations, particularly low-income and educationally disadvantaged older adults. Most of them have underlying chronic diseases or comorbidities that increase their risk of a COVID-19 infection. The social isolation instigated to comply with COVID-19 biosecurity curtailed the already limited social activities that elderly used to enjoy, affecting negatively their mental and physical health. Preventing COVID-19 in older people is particularly important because they are among the more susceptible population and more prone to</p>	Family Well-Being

<p>during COVID-19 pandemic</p>	<p>develop severe complications. Furthermore, their caregivers are affected by the negative impact of COVID-19 because of emotional, physical and financial stress. At this time, the Family Health and Wellbeing PRAES component worked on promoting health and disease prevention education focusing on the elderly, as well as their caregivers, to improve their quality of life, especially now in emergency situations. Our educational interventions included in-person interactions with small groups and online activities.</p> <p>Target audience The audience for our educational activities and interventions were mostly older adults, their caregivers and families who benefited from receiving educational assistance on how to prevent COVID-19 and to better cope with the stressors associated with the lockdown.</p> <p>What has been done? We developed and delivered non-formal education activity tools such as courses, webinars and workshops related to COVID-19, prevention of health issues and promotion of good practices for daily activities such as: how to stay safe, support in alleviating feelings of loneliness and social isolation, leisure time and physical activity, fall-prevention plans, taking care of mental health, self-care during public health emergencies; also financial fraud prevention and food safety training.</p> <p>Results Since the very beginning of the COVID-19 (prior to Puerto Rico's lockdown), Extensionists had been supporting our vulnerable communities with non-formal educational programs. A total of 10,739 subjects (mostly older adults and caregivers) participated in our face-to-face workshops and courses, and webinars related to daily living activities for the elderly. Among the courses/webinars that Extensionists conducted and the corresponding participants (n) included: Taking care of your mental health (n=551); Food safety management (n=233); Managing emotions in times of uncertainty and stress (n=551); Financial fraud and protection(n=327); Selfcare for preventing falls and physical activity (n=203); COVID-19: Environment, health and food safety (n=1,500); Handwashing</p>	
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(n=54). These participants benefited by acquiring knowledge and skills to cope with the COVID-19 crisis, different aspects of their daily lives and routines. The main changes that older people/caregivers reported adopting after participating in our courses were: improved the ability to manage stressful/mental health situations such as depression, loneliness, negative emotions (n=366); incorporated physical activities in their daily routine (n= 87); increased the ability to prevent financial fraud (n=190); adopted precautions to avoid slips and falls at home (n=137); increased self-esteem and self care (n=185); incorporated healthy habits regarding food safety (n=202).

External Factors (optional)

N/A

Other information such as relevant websites is optional.

Facebook Live: COVID-19: Environment, health and food safety:

https://www.facebook.com/watch/live/?v=2797412Y13718158&ref=watch_permalink

Facebook Live: Handwashing:

https://www.facebook.com/watch/live/?v=3553909814660468&ref=watch_permalink

Food safety and basic food basket during COVID-19 times:

<https://www.listennotes.com/podcasts/meinforma/tema-seguridad-alimentaria-y-2B6DI5fOAWI/>

Managing your finances

<https://business.facebook.com/sea.uprm/videos/594143984529483/>

Purchasing and managing foods safety

<https://business.facebook.com/sea.uprm/videos/547687409487894/>

Food Security and the Basic Basket for Puerto Rico, A challenge to COVID 19

<https://business.facebook.com/sea.uprm/videos/242830736828135/>

Stress as an important factor for your health

<https://business.facebook.com/sea.uprm/videos/242830736828135/>

<p>23.</p>	<p>Access, Equity and Opportunity; the Power of Youth.</p>	<p>What is the issue? Over the past three years, young people in the Caribbean archipelago have faced emergencies caused by hurricanes, earthquakes and now a pandemic. The lack of educational opportunities and inaccessibility to food due to closing of schools, economic challenges, and a more alarming situation, domestic violence worsening because of the lockdown increase youth vulnerability. These challenges are a potential physical and emotional threat to both children and adolescents</p> <p>The educational system and youth programs have had to redesign their activities to attend to audience needs. It is important to work with response strategies, educational processes and to encourage opportunities for vulnerable populations, for diverse needs and different social conditions. Empowering youth, staff, and volunteers to better understand and address the community diversity of needs contributes to design and delivery initiatives with social responsibility and equity.</p> <p>Target audience Extension Educators and 4-H Youth Leaders and communities were trained to improve their capabilities to identify the needs of Puerto Rico's Youth and Families.</p> <p>What has been done? Our program combined the Positive Youth Development (PYD) and the Social Determinants of Health (SDoH) approach to incorporate inclusive and diversified activities such as youth-adult partnerships, virtual and at home learning, virtual camps, forums, among others. Activities were designed to engage teens, families and extension staff in educational processes to better prepare them to cope with the challenges associated with the lack of educational opportunities, access to fresh and healthy foods, economic challenges, and other social conditions. As a result of the lockdown, we developed positive and creative ways to support teen well-being through 4-H activities. These activities provided opportunities to develop and reinforce the 4-H essential elements (mastery, generosity, independence, and</p>	<p>Positive Youth Development</p>
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belonging) and promoted the development of skills like teamwork, empathy, communication, leadership, decision making, and critical thinking, among others. Examples of these activities included the 4-H week, Community Service and Natural Resources where 1,132 youth benefited.

The initiative “Extensionists and Youth Designing Together” created opportunities in which youth and extension staff developed new educational tools used to prepare the new delegates to participate in the National 4-H Conference.

Results

The **Route for a Healthy living** is one of our distinguished programs designed and delivered by 4-H youth and extension staff. The program combined PYD, SDoH and nutrition to teach the audience about healthy habits in our communities. The 2020 Healthy Living Summit trained five 4-H Leaders to design and develop the Healthy Habits Conference of PR where 87 youth were trained to become teen-teachers. Fifty-five adults (PRAES staff and volunteers) were also trained to develop strategies to respond to food and nutrition needs in their communities. Together youth (87) and adults (28) worked on the Route for Healthy living initiative. Using a virtual platform, they reached around 408 participants who completed six healthy living lessons. [RUTA 4-H Para una vida saludable | Facebook](#)

In order to continue the educational efforts of the 4-H program during times of pandemic, the **4-H Healthy Living Ambassadors** (4-H Congress participants; n=5) served as spokespersons to share their experiences with the 4-H Program through Virtual Forums “Listen to my Voice, I am 4-H” to encourage youth (n=86) to improve their life styles during pandemic times. These 86 youth with the counseling of 26 Extension Members and the help of 25 4-H teen volunteers prepared an educative digital series used to provide virtual training to a total of 408 youths. These experiences were published on the Extension Service FaceBook page where a total of 6,402 people were reached with 579 engagements

<https://business.facebook.com/sea.uprm/videos/910484459451394/>

In collaboration with extension staff and a youth leader (studying in Spain) and raised in this program, the group presented the **Virtual Forum: Foods, Nutrition and Careers** to promote college and career readiness in youth. For participants speaking with an alumna from Spain was an amazing and encouraging experience.

The **Virtual Summer Camp** provided educational activities to 100 participants around the island. Five 4-H Youth Leader-Health Promoters (previously trained as Health Promoters) worked with extension staff to facilitate the recreational and educational activities of the Summer Camp. The camp included workshops and conferences related to preparedness for emergencies, empowered youth and kids to better cope with the COVID-19 lockdown and to better address emergencies by developing confidence and resiliency. The lessons offered during this camp were completed by 121 students.

<https://classroom.google.com/c/MTI4Njk1MDUzMzM2?cjc=aqclhoc>. A parent quoted "*the 4-H Virtual Summer Camp represented an Oasis during these difficult times of the lockdown*". Additionally, the virtual camp integrated two virtual 5K races during summer programs in which more than 150 participants completed the event. The summer camp remained open even after the end of the activity to continue providing educational lessons to interested youth.

Puerto Rico was selected to be part of the **True Leaders Equity Institute**. The team was composed of two 4-H members with more than 5 years in the 4-H program, and one 4-H volunteer-alumni and one PRAES staff member. This team developed the proposal OYE, an initiative to provide a safe and inclusive environment for deaf and blind youth inside the Puerto Rico 4-H Clubs. OYE will address the common barriers that have impeded blind and deaf youth to take part in the 4-H program of Puerto Rico. The proposal was presented to a board and accepted. A team of twelve 4-H youth and staff took language sign classes and have dedicated more than 30 hrs. to identify teaching resources, coordinating with more 4-H participants and converting traditional educational materials to resources for blind and deaf participants. [Gallery Visit \(LA, NY, PR, UT\) - YouTube](#)

The **4-H Ag-Challenge** is a collaborative effort with Corteva Agri-Sciences that aimed to connect and reconnect our 4-H members with agriculture, ag-related businessmen and professionals. Extension Staff (Extension Agents and Family and Consumer Sciences Educators), PRAES Specialist, and all four Extension Educational Programs and the PRAES Integrated Pest Management Program joined efforts to develop skills and awareness about the significance of pollinators (The Honey Bee Challenge) in agriculture and in our daily lives. A total of 175 kids and youth participated in this initiative and as a result, 125 families established pollinator gardens at home. [Cientos de jóvenes boricuas completan primera fase de reto agrícola | Metro](#)

The **Life Skills** program provided educational activities related to developing basic leadership and life skills to 1,928 participants. Of these participants, 26 demonstrated their adoption of skills through their outstanding participation in national events like, 4-H Hall of Fame (1), National 4-H Congress(13), National Science Summit (3), National Healthy living Summit (5) and True Leaders Equity Institute (3).

External Factors (optional)

The southwest Puerto Rico earthquakes and COVID-19 decreased activities like camps, internships, and other face-to-face activities.

Other information such as relevant websites is optional.

Our program received funding and collaboration from:

Red-Cross /Cruz Roja, National 4-H Council-TLEI, Wall-Mart Foundation, US Forest Service, ASSMCA/ Department of Health, Partnership for success, Department of Agriculture PR, WIPR TV- PR Government Media

4-H volunteer providing training to youth from her transitory Home Trailer after losing her house due to the earthquakes of January 2020.

https://drive.google.com/file/d/1x_tAVeHrjEsglzU1i2wOHg9a5iZ106i/view

[The 4-H House Tree Page](#)

[\(1\) Casa del Árbol 4-H | Facebook](#)