

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

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

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

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

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

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

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

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

Publications:

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

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

Critical Issue

Food security, plant & animal systems

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

Project Director

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Publications: (Journal publications):

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

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

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

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

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

(Other publications):

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

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

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

Other Products:

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

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

Project Director

Jaime Curbelo

Organization



Providing tools through PRAES to enhance coffee quality and marketing opportunities

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

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

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

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

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

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

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

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

Fertility and embryo characterization of slick hair Holstein cattle

Project Director
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Accession Number
1025357



Fertility and embryo characterization of slick hair Holstein cattle

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

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

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

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

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

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

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

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

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

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

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

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

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

Publications

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

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

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

Closing Out (end date 01/17/2024)

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

Project Director

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Organization

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Accession Number



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

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

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

So far we have had 3 reproductive synchronizations events that have resulted in 61 (31+18+12) calves that have been part of 6 nutrition trials comparing growth rates between slick and wild type dairy cattle. Of those 61 calves, 31 calves, now heifers, were synchronized and inseminated with a heterozygous Slick bull that is also polled. Concomitantly, 36 adult cows were also be synchronized and inseminated with a heterozygous Slick bull that is also polled. The offspring of these cows is currently been part of additional nutrition trials, but in this occasion we are comparing homozygous Slick calves against heterozygous Slick and wild type calves. Since August 2022 we have been finally using the automatic milking system (Feeding robot) and we are maximizing resources by also comparing the growth of wild-type animals growing under robotic management with the growth of wild-type animals growing under manual labor and with less space allotment per calve.

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

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

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

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

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

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

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

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

Characterization of rumen and hindgut microbial communities in slick and wild-type Holstein calves in a tropical climate. **Marieli Ruiz-Cortés,** Natalie M. Meleñdez-Vázquez, Mariela Torres-Rivera, Guillermo Ortiz-Colón, and Filipa Godoy-Vitorino

Efecto de la disponibilidad de espacio en la salud, en la ganancia en peso y el desarrollo esquelético en becerros Holstein. **Grecia D. Rosario García,** Cristian R. Perdomo Garcí?a, Carolina I. Rivera Camacho, Ange?lica M. Silva Perea, Mariela D. Torres Rivera, Ge?nesis Agosto Burgos y Guillermo Ortiz-Colón

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

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

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

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

Publications:

Other publications, conference papers and presentations:

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

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

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

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

Other Products/Outputs:

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

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

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

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

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

Project Director

Alfredo Aponte-Zayas

Organization

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1021262



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

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

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

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

Objective 1. Visual field observations were performed on the incidence of pests and diseases during the early plant establishment. The varieties that were best adapted to organic systems were: beans var “Beniquez”, cucumber var “Gurabo”, cowpea var “Gorda”, eggplant var “Rosita”, sweet cherry pepper var “Bonanza”, tropical pumpkin var “Taina Dorada” and sweet potato var “Pujols”.

Objective 2. Field observations to control weed pressure- The treatments using bio-degradable plastic mulch and hay mulch were the best suppressing weeds in Lajas Puerto Rico. In Gurabo Puerto Rico the weed suppression trial will be established on February 2023 due to the climate conditions. A project extension will be requested in April 2023 due to these weather-related delays.

Objective 3. A database was created with the voluntarily provided contact information of visitors and participants in organic farms project’s activities, and of buyers of organic seeds at Lajas substation. A preliminary profile of these stakeholders was prepared with the available information on municipality of residence, occupation, and reason for visit or educational activity attended. A questionnaire for a follow-up survey of these audiences was prepared and is currently being tested. Work has also continued in an annotated bibliography of organic farms projects results and identified knowledge gaps.

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

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

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

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

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

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

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

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

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

Publications:

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

Other Products:

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

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

Project Director

Alfredo Aponte-Zayas

Organization

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1021260



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Other Products-

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

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

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

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

Project Director

Hector Sanchez-Rodriguez

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

Final Result

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

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

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

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

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

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

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