Project Number: S-009

Project Title: Plant Genetic Resources Conservation and Utilization

Period Covered: 07/2021 through 8/2022

Date of this Report: August 29, 2022

Annual Meeting Dates: August 16-17, 2022

Participants and Minutes:

https://www.ars.usda.gov/southeast-area/griffin-ga/pgrcu/docs/s-009-annual-reports-and-minutes/

Accomplishments

A large and highly diverse set of plant germplasm was preserved and distributed to scientists, educators, and plant breeders. A total of 103,176 accessions of 1602 plant species representing 281 genera were maintained in the Griffin plant genetic resources collection. Over 87% of these accessions were available for distribution to users and over 94% were backed up securely at a second location. A total of 51,773 seed and clonal accessions were distributed upon request to scientists and educators worldwide in 2021. Sorghum and cowpea were the most distributed crops. Clonal collections were continually maintained and distributed to stakeholders. Clonal collections include warm-season grasses, bamboo, Chinese water chestnut, perennial peanut, and sweet potato. Preservation methods include tissue culture, field plots, greenhouse plants, and hydroponics. A total of 2,590 accessions were sent to curators for regeneration. Collaborator regenerations led to successful regeneration of many crops including wild peanut (Griffin, GA), sorghum and millet (USDA-ARS, Puerto Rico) and vegetable crops (USDA-ARS, Parlier, CA; Rijk Zwaan; Vilmoran; HM Clause; Curry Seed and Chile Company). These activities ensure that the crop genetic resources at the Griffin location are safeguarded for future use to develop new cultivars and identify novel traits and uses in our food and fiber crops.

The collaborative project with researchers at the University of Georgia-Tifton Campus to develop molecular diagnostic tools for the detection of peanut clump virus and the Indian peanut clump virus with funding support from the National Plant Disease Recovery System (NPDRS) was completed. Molecular diagnostic assays were developed and standardized for the detection of these two viruses. Protocols were shared with USDA-Animal Plant Health Inspection Service (APHIS) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for validations. These diagnostic tools are needed to screen new peanut germplasm entering the country.

With partial support from the National Peanut Board, Peanut Research Foundation and NIFA, the genetic characterization of all species of the section Arachis has been completed. This is aiding the positive identification of species and accessions. As a second phase, the production of peanut-compatible allotetraploids is being done in a systematic fashion to unlock wild alleles for the peanut breeding. A dedicated collection of peanut-compatible wild derived germplasm will be created.

CRISPR gene editing is a new technology to precisely modify traits for crop improvement. Collaboration continued with Tuskegee University on a gene editing project for peanut with hopes of increasing the health beneficial oleic acid content. In collaboration with ARS researchers in Tifton, GA, fatty acid composition was determined in 349 recombinant inbred lines (RIL) from the peanut MAGIC population. This population has parents with high oleic acid content and resistance to both leaf spot and the tomato spotted wilt virus. The goal of the project is to develop peanut germplasm lines with both the high oleic acid trait and disease resistance.

In collaboration with the University of Georgia wild peanut lab, three elevated oleic acid lines were identified in populations developed from a synthetic tetraploid peanut. This facilitates the introduction of traits from wild peanut species into cultivated peanut for the development of improved peanut varieties. With the same research group, 100 wild peanut accessions were genotyped with a single nucleotide polymorphism (SNP) array. The collected seeds will be assayed for seed quality traits including oil and protein content, fatty acid composition, and resveratrol content. The purpose is to associate nutritional quality traits with the SNP markers for use in marker-assisted breeding.

Collaboration continues with ARS researchers in Charleston, SC to cross the wild species related to watermelon, *Citrullus ecirrhosus*, with cultivated watermelon species. This species is being evaluated for resistance to root knot nematodes which are a problem in watermelon production areas in the southeastern United States. A new source of resistance could be used to develop improved watermelon varieties. A collaborative study was initiated with the University of Houston Medical Center and the University of Georgia to determine the genomic basis for sex determination in watermelon. Understanding how chromosome evolution in the genus occurred can be used to better understand the evolution of agriculturally important genes.

Pepper accessions were screened for the presence of Tomato Brown Rugose Fruit Virus. The presence of viruses or the lack of knowledge concerning the presence or absence of viruses in germplasm hinders the ability to distribute germplasm and can result in the unintentional distribution of plant pathogens. Collaborative efforts with ARS researchers in Stoneville, MS to identify and characterize novel uses of bioactive compounds in pepper including capsinoids continued. Capsinoids, the substance that gives peppers their hot pungent flavor, has been shown to be an important nutraceutical compound with many potential health benefits.

Glactomannan (gum) concentration was measured in twelve guar accessions using High Performance Liquid Chromatography. Due to its high viscosity, guar gum is a popular polymer used in oil well drilling for hydraulic fracturing and in the food industry as a stabilizer for frozen and baked foods and a thickener for salad dressing. Identification of guar accessions high in gum concentration is useful in the development of guar varieties with improved commercial traits.

Impacts

Germplasm distributed by researchers of this project resulted in numerous publications, plant variety releases, and patents as detailed in the state reports provided by the S-009 State Representatives. The state reports are provided below to document this impact. The reports have been abbreviated to comply with formatting requirements in NIMSS. Full state reports, including tables, can be found at https://www.ars.usda.gov/southeast-area/griffin-ga/pgrcu/docs/s-009-annual-reports-and-minutes/.

State Reports Submitted in 2022

Alabama

Charles Chen, University of Alabama

According to records provided by S-009, a total of 635 accessions were mailed to Alabama from 2019 to 2021. In 2021, the requested germplasm covered 8 genera, They are Okra, Peanut, Peppers, Sweet potato, Watermelon, Cucumber, Legume, Eggplant, and Cowpea. The most requested crop was sweet potato by Tuskegee University. The recipients of requested germplasm were university scientists, consultants, seed companies, gardeners and citizens of Alabama. The largest number of accessions was requested by Dr. Egnin, M at Tuskegee University for sweet potatos (15 accessions), and by Dr. Josh Clevenger from HusdonAlpha institute for Biotechnology for bambara bean (15 accessions), following H. Mcbrayer from

the Alabama Fruit and Vegetable Growers Association for watermelon (4 accessions), A total of 7 individuals in AL required germplasm. Community Garden for Nolan and Zora Jean required peppers, cucumber, eggplant, cowpea, okra and watermelon.

Arkansas – No report submitted

Florida – No report submitted

Georgia
Soraya Leal-Bertioli, University of Georgia

In the state of Georgia, 50 requests for plant germplasm were made to in 2021. As a result of these requests, S-009 provided 781 plant accessions. The recipients were University scientists (677 accessions/1089 accessions in previous reporting period), USDA scientists (93/164 in previous reporting period), and US individuals with no affiliation (11/16 in previous reporting period). The most requested crop was sorghum (624 accessions).

The University of Georgia maintains strong emphasis on plant breeding and continues to expand its advanced molecular biology programs. The Institute of Plant Breeding, Genetics, and Genomics at UGA currently has 50 total faculty members, being 30 full faculty (one starting in 2021: Robin Buel) from the departments of Crop and Soils Science, Plant Pathology and Horticulture, six adjunct faculty, eight affiliated members from the USDA (one starting in 2021: Nino Brown), and three emeritus members. The main mission of the Institute is to develop improved plant cultivars from agronomic and horticultural species of importance to Georgia, the U.S., and worldwide. UGA currently has active cultivar development programs in soybean, peanut, small grains, cotton, turfgrass, forages, blueberry, pecan, grape, pepper, peach, watermelon, and numerous ornamental crops that frequently utilize the plant genetic resource collections. These cultivar development programs released 14 cultivars and 12 plant registrations between Aug 2021- Jul 22. In addition to that, 18 Plant Patents and six PVPs were granted between Aug 2020- Jul 21.

Faculty is also engaged in training graduate students and the graduate program currently has 51 students (20 MS and 31 PhD), and post-docs involved in various aspects of plant improvement. These programs supply new crop cultivars and associated technologies to our agricultural sector and rely heavily upon the plant materials maintained within the S-009 unit. The 54 publications produced in the period 2021-2022 (listed below) demonstrate the importance of this germplasm for education and advancement of science. Twenty-five of these publications had the participation of IPBGG graduate students, demonstrating the emphasis of personnel development given by the Institute.

Research programs in crop science, horticulture, plant pathology, entomology, molecular biology and other disciplines continue to utilize the genetic resources of the S-009 unit in both basic and applied research projects designed to address the needs of Georgia and U.S. agriculture. The S-009 unit remains a critical component of our research, cultivar development, innovation and student training programs in Georgia.

Guam
Mari Marutani, University of Guam

Hibiscus sabdariffa

Field Trial 2021: Nine *Hibiscus sabdariffa* accessions originally obtained from the USDA-ARS S9 Unit at the University of Georgia were evaluated for their field performance and phytochemical analysis of calyxes and leaves by transplanting 3-week-old seedlings on February 12, 2021. Accessions included: PI

256039, PI 265319, PI 273389, PI 275413, PI 275414, PI 291128, PI 500706, PI 500713, and PI 500724. Plants were irrigated twice daily for 20 min using a drip irrigation system. The field was weeded, and pesticides were applied as needed. Plants were fertilized weekly with 20-20-20 (NPK) and bi-weekly with iron chelate. All plants had a long period of vegetation stage as they were short-day plants. Some accessions produced calyxes only in November and December. Since this growing period coincided with rainy season, most plants were severely infested with a fungal disease, *Fusarium* wilt, and this field experiment was terminated without recording the plant growth data.

The same *Hibiscus sabdariffa* accessions were planted again on September 20, 2021. Plants are now being cultivated for collection of leaves and calyxes to determine their phytochemical properties. In preliminary studies, mature leaf samples were examined for the presence of seven flavonoids by high-performance liquid chromatography (HPLC) and the results indicated that all accessions except PI 273389 and PI 500724 contained cyanidin 3-sambubioside, cyanidin 3-glucoside, delphinidin 3-sambubioside, delphinidin 3-glucoside, protocatechuic acid, chlorogenic acid, and quercetin.

Ipomoea batatas

Two field studies were conducted to evaluate 21 sweetpotato (*Ipomoea batatas*) accessions (S-9 and local lines) in Guam cobbly clay soil at the Guam Agricultural Experiment Station Yigo farm during the rainy season from July to December 2020, and the dry season from January to May 2021. There were ten plants per plot in a randomized complete block design with four blocks. Rooted stem cuttings were transplanted in the field on January 13, 2021, for the dry season trial. The field was irrigated by a drip irrigation system and was fertilized by injecting a 20-20-20 (NPK) weekly for 12 weeks. Mulch was applied onto the sweet potato mounds to reduce crop-weed competition during the early stages of growth using ironwood (*Casuarina equisetifolia*) needles. Weeding was performed as needed. Plant and storage root characteristics were determined according to the International Board for Plant Genetic Resources (IPGR). For inflorescence data, not all the sweetpotato cultivars and replications were flowering at 45 days after transplanting. In the trial of January to May 2021, eight accessions (Accession code: PI 653844 (cv. Liberty), Stokes, SP15-0001, SP16-0003, SP16-0004, SP16-0007, SP20-0009, SP20-0010) flowered at 45 days after planting. Three growth types were recognized: eight accessions showed the growth type as semi-erect plant; eight accessions had a spreading plant type; and five were extremely spreading type. For production of storage roots, during the growing season of July to December 2020, only four accessions (PI 531149 (Amarillo Local), SP16-0004, SP20-0008, SP20-0009) produced mature storage roots during the growing season from January to May 2021, all accessions produced storage roots. Ten accessions produced a low yield, five accessions produced a moderate yield, and six accessions produced a high yield. Most accessions had storage roots with dark purple to purple skin and a cream-colored flesh. Two accessions had light orange flesh color, and one accession exhibited purple pigmentation in the flesh.

Kentucky
Timothy Philips, University of Kentucky

In 2021 a record low number of accessions from S9 was shipped to Kentucky addresses. Only four accessions (3 sorghums and one pumpkin) were requested by two people. Parker Camp is affiliated with the University of Kentucky through a startup company, Red Leaf Biologics. They produce novel, stable anthocyanin plant dyes from mutant sorghum lines. The recipient of the pumpkin accession did not respond to an email requesting how it was used. In 2020 a total of 159 accessions were shipped to six Kentucky addresses. These include a Ph.D. Anthropology student, a Cannabis/CBD company, and two

university faculty members (University of Kentucky and Austin Peay State University which is in Tennessee but on the border of Kentucky and the request of several millet species resides in Kentucky. A few small vegetable farmers have requested several accessions of pepper, watermelon, okra, and pumpkin in recent years. Perhaps decline in accessions requested from Kentucky residents is due to the COVID-19 pandemic, and more accessions will be shipped to Kentucky soon.

Louisiana
Don Labonte, Louisiana State University

A sweetpotato variety was released in 2021 "Vermillion". This variety has a red-purple skin and represents a complement to the "Diane" variety. "Vermillion" has better storing properties than "Diane" but does have slightly less yield. Sweetpotato germplasm requests from the S-9 repository serve two purposes: 1) in search of a source of resistance to specific diseases, and 2) to evaluate resistance to diseases of germplasm in the collection to assist the curator in expanding the information in the characterization database. Specifically, we have requested germplasm to search for a source of resistance for the recently re-emerged black rot pathogen, *Ceratocystis fimbriata*, and for the recently introduced guava root-knot nematode, *Meloidogyne enterolobii*. USDA-APHIS-PPQ has a significant number of requested accessions now being processed for ultimate release. Research on Periglandula fungal symbiosis with Ipomoea (morning glory) species was conducted. Seeds of several *Ipomoea* species from GRIN were tested for infection by the symbiotic Periglandula fungus including *I. graminea*, *I. hildebrandtii* and *I. parasitica*. The *Ipomoea* seeds was infected. The peanut variety was ordered to conduct the North Carolina Differential Host Test for identification of southern root-knot nematode (*Meloidogyne incognita*) race. The original publication used 'Flo-runner' as the peanut variety, but this is no longer available. Tiffrunner (PI644011) can be used in place of Florunner for nematode race characterization.

Mississippi
Brian S. Baldwin, Mississippi State University

In 2021 scientists (and a resident) of the State of Mississippi requested and received 420 germplasm accessions; 376 were *Sorghum bicolor*, 21 turf of six species, 13 peanut, eight of two pepper species, and one hibiscus.

Sorghum bicolor germplasm was used for (environmental) stress physiological experiments lead by Dr. K. Raja Reddy at the Soil-Plant-Atmosphere Research facility at Mississippi State University.

Turf species were composed of six species: centipedgrass (*Eremochlaoa ophiuroides*), carpetgrass (*Axonopus* spp.), and bermudagrass (*Cynodon* spp.). All species were part of the larger turfgrass breeding program lead by Dr. Hongxu Dong at Mississippi State University. Species were evaluated for suitability for incorporation into the turfgrass breeding program and herbicide and insecticide tolerance.

Peanut accessions were requested by Dr. Wang at the USDA Natural Products Center in Oxford, MS for lipid analysis and composition. The ultimate purpose of her research is to identify specific naturally occurring lipids for commercial exploitation. Dr. Zuweller is the new peanut research and extension faculty member at the University. His work is just getting underway. Requested germplasm is being used as checks for experiments on defoliation, yield and pegging due to soil conditions.

The five Capsicum annum and three C. chinense accessions were requested and sent to a private entity (D. Riser) with no research affiliation.

Hibiscus species have been used extensively by Dr. Sakhanokho at the USDA facility in Poplarville for varietal development, disease screening and physiological experiments.

North Carolina
Carlos Iglesias, North Carolina State University

Over the past three years (2019 – 2021), institutions in North Carolina requested 1226 accessions from the PGRC unit at Griffin. Of these, 547 were requested in 2021, 262 in 2020, and 417 in 2019. We received use reports for 72% of the accessions (877 of them). The five largest number of accessions requested by genus was: Sorghum (625); Lagenaria (180); Abelmoschus (151); Vigna (69); and Arachis (38); representing 87% of the total number of accessions requested by institutions in North Carolina.

The host range of MMV (maize mosaic virus) and its plant hopper insect vector, *Peregrinus maidis* was tested with a small number of species of grassy and broadleaf weeds and agronomic crops. Controlled dispersal experiments in cages designed to approximate maize in proximity to perennial and annual weedy grass species demonstrated host specificity of the virus and vector. Seed from *Panicum virgatum* and *Sorghum bicolor* subsp. *bicolor* were obtained from GRIN S9 to use as weedy species in the host range assays (Dr. Lahre).

Citrillus germplasm was used to isolate high-quality DNA to perform RenSeq approach to identify genes that codes for NLR type receptors on plant genomes. Drs. Salcedo and Quesada are analyzing the data and we are planning to release data and publications early 2023.

Also, *Citrullus* germplasm was used to introgress disease resistance into elite watermelon populations, and was also used in disease screening studies by Dr. Wehner's lab. The same lave requested Lageneria germplasm to evaluate seedling traits and chilling tolerance. The studies were published in 2020 and 2021

Germplasm samples were used in a genetic study examining the species relationships among sweetpotato wild relatives: *Ipomoea cynanchifolia* and *Ipomoea trifida*. The leaf transcriptome was sequenced, along with several other *Ipomoea* taxa; these two samples were used to as representative species in the study. The study was focused on characterizing a taxon that was not previously described to be found in North America – *Ipomoea grandifolia*. *Ipomoea cynanchifolia* clusters with *Ipomoea grandifolia*, as consistent with other studies. *Ipomoea trifida* appears to be distantly related to *Ipomoea grandifolia.*

Arachis germplasm was used to validate seed sources already in the North Carolina State University peanut germplasm collection by Drs. Dunne and Andres. The following studies required the validation of the peanut germplasm lines reported in S9 over the past 1 to 3 years:

a. Recombinant Inbred Lines (RIL) populations for the improvement of folate content in peanut:
b. Whole-genome sequencing of wild species derived peanut germplasm for molecular marker development and marker-assisted selection:

In St. Augustinegrass (*Stenotaphrum secundatum*), previous work at NCSU identified PI 410353 among others as resistant to grey leaf spot disease (Carbajal et al, 2020), as well as PI 365031 and 289729 among others as resistant to the southern chinch bug (Milla-Lewis et al 2017). The Turfgrass lab continues to works with these PIs to 1) breed for resistance to these traits, and 2) identify QTL underlying these traits

in order to develop marker-assisted selection programs. Additionally, as part of a Specialty Crop Research Initiative grant genomics objective, we are interested in looking at allelic diversity in a broad range of germplasm for disease resistance as well as drought tolerance. All St. Augustinegrass PIs currently held in GRIN will be included in this study.

Okra (*Abelmoschus esculentus*) accessions were introduced in North Carolina to start the okra breeding program by the Plant Breeding Graduate Student Club at NCSU. Generations of multiplication and observation have been conducted in greenhouse and field, including some practice crossings. Field observations and selections were made in the field during 2021. Selections are being grown in 2022. The target is to develop okra varieties that combine different flower and pod colors as ornamental types .

Okra accessions were also acquired by the Utopian Seed Project (USP). One promising variety has been Puerto Rico Evergreen. Selections were made from this population and released seeds through Southern Exposure Seed Exchange this year as Puerto Rico Everblush. The USP worked with the higher oilseed content accessions. Crosses were made in 2021 and the top 10 F1s were selected to grow out this year. Next year USP will grow the F2s and begin selection for higher oil content material. The USP has also evaluated accessions from other species of the genus *Abelmoschus*. USP is especially interested in tropical *A. manihot* subsp. *manihot* and *A. caillei*.

Thirty accessions of Bambara groundnuts (*Vigna subterranean*) were introduced and increased in greenhouse this past Spring (2022). The goal is to evaluate the potential adaptation of the specie as an alternative crop for peanut growers in North Carolina. The main target is the alternative protein market, given that there are already companies developing protein products based on Bambara groundnuts in Asia. NCSU also received 200+ accessions from IITA (Nigeria). The intent is to evaluate both collections in the field during the summer of 2023.

Dr. Doherty's lab used Sorghum bicolor for analysis of early-season chilling tolerance. RNA was sampled for RNA-Seq analysis, which has been submitted, but not completed yet and are performing validation studies on these lines. The study will evaluate how the transcriptional machinery varies based on the time of day using Western Blots. First manuscript to be submitted in the next month.

Dr. Horn's lab acquired seeds from two S9-provided germplasm including *Ipomoea alba* and *Psophocarpus tetragonolobus*. These plants were chosen due to high amounts of unusual fatty acids, i.e., hexadecenoic and octadecenoic acids, according to published sources curated in PlantFAdb. (https://plantfadb.org). These seeds were acquired as part of a larger survey of unusual fatty acids in seeds. Unfortunately, this project was temporarily abandoned due to the pandemic, which led to limited personnel and funds. The seeds are still in our possession and may be analyzed in the future as part of other funded projects.

Dr. Hornstein's lab ordered a wide range of germplasm (*Abelmoschus, Cenchrus, Digitaria, Eleusine, Macrotyloma, Ricinus, Sesamum, Sorghum, Vigna*) intended to test a new method of plant transformation with greater robustness across species and cultivars; unfortunately, that project was stalled by the pandemic and has not restarted.

Dr. Alvarez-Rellan's lab has used a collection of Sorghum accessions for studies on understanding metabolic adaptations to environmental stresses. They are currently performing genetic mapping of metabolic traits with these materials.

Accession PI 564163 *Sorghum bicolor* (L.) Moench subsp. *Bicolor* was included in the project: "Comparative genomic and spatial analysis of DNA replication in maize and sorghum". Dr. Hanley-Bowdoin's lab extensively studied DNA replication dynamics in maize root tips and now plan to generate comparable data in Sorghum. The supplied Sorghum seed has been used to bulk up seeds stocks for future experiments and for some small scale optimization experiments including developing seedling germination and root tip harvesting protocols, and protocols for labeling root tip cells in S-phase with a thymidine analog, Ethynyl deoxyuridine, for future flow cytometry and NGS sequencing experiments.

Oklahoma
Yanqi Wu, Oklahoma State University

Plant germplasm users in Oklahoma requested a total of 2,374 accessions maintained at the USDA ARS Plant Genetic Resources Conservation Unit at Griffin, GA in this reporting period. The Oklahoma users included scientists at Oklahoma State University, USDA ARS laboratories, Noble Research Institute, Oklahoma University, and private business, and farmers. The requested plant germplasm included peanuts (*Arachis* spp.), clovers (*Trifolium* spp.), sorghum (*Sorghum* spp.), grasses (*Cenchrus* spp., *Zoysia* spp., *Axonopus* spp., *Panicum virgatum*), cowpea (*Vigna* spp.), watermelon (*Citrullus lanatus*), pepper (*Capsicum annuum*), white morning glory (*Ipomoea* spp.), etc. The number of requested germplasm in 2022 (2,374) is much larger than that in 2020 (981) and 2021 (872). It is not easy to know how these requested germplasm were used. However, many of the germplasm requested by scientists were used in their scientific investigations.

Puerto Rico
Carlos Flores Ortega, University of Puerto Rico

Legumes Registration approval in the AES Variety Committee of PR1654-7 red mottled bean germplasm line. PI: Dr. James S. Beaver. Bean golden yellow mosaic virus (BGYMV), Bean common mosaic virus (BCMV), Bean common mosaic necrosis virus (BCMNV) and common bacterial blight (CBB) caused by Xanthomonas axonopodis pv. phaseoli (Smith) Vauterin et al. are important diseases of dry beans (Phaseolus vulgaris L.) in the Caribbean. The development of dry bean cultivars and germplasm having enhanced levels of resistance to these, and other diseases and pests is an important goal of the University of Puerto Rico (UPR) and other dry bean breeding programs in the Caribbean. PR1654-7 is a multiple virus and CBB resistant red mottled bean germplasm line adapted to the humid tropics that was developed and released cooperatively in 2021 by the UPR Agricultural Experiment Station, the Instituto Dominicano de Investigaciones Agropecuarias y Forestales and the USDA-Agriculture Research Service. PR1654-7 possesses the bgm-1 gene for resistance to BGYMV and the I and bc-3 loci that confer resistance to BCMV and BCMNV, respectively, 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 in the tropics.

Evaluation and breeding continue in agronomic performance of common and tepary bean genotypes and their response to ashy stem blight in the southern coastal zone of Puerto Rico. PI: Dr. Diego Viteri.

Forages Evaluation and breeding continue in Tropical forage legume and grass. Genotypes evaluation and maintenance for the different agro-ecosystems of Puerto Rico and Caribbean Zone are extremely

important due to the necessity to increase the local forage consumption principally in the milk industry due to the high cost of imported grains. PI: Dr. Elide Valencia.

Fruits Passion fruit (Passiflora edulis) accessions evaluation continues. A new trellis supported infrastructure was constructed at the Isabela AES. A second year of evaluation will be necessary to evaluate accessions difference in vine thickness and vigor. PI: Dr. Pablo Morales Payan Quenep (Quenepa)

(*Melicoccus bijugatus*) Evaluation consist of 18 quenepa clones being carried out to culminate the Phenotypic description, morphology, and production evaluation in the Juana Diaz AES collection. Final Report will be submitted this year 2022-2023.

Citrus After the Hurricane Irma and Maria in 2017, Citrus plantations were one of the most affected and difficult to recuperate in the Island. Special care was taken by Scientist to secure and protect the accessions considered historically important genetic resources for the citrus production in the Southern Region and worldwide. Today accessions are secure and protected in a screen house in Adjuntas AES located in the central mountain region of the Island. Maintenance and propagation of citrus germplasm pest free continues and secure by replicates in Corozal and Isabela AES. Citrus rootstocks and scion's evaluation continues at different locations. Great farmers interest for establishing new citrus plantations has been observed in the las three years. PI: Dra. Rebecca Tirado. The Department of Agriculture of Puerto Rico incentives farmers to establish new plantations only CTV free.

Banana and Plantain Evaluation, maintenance, and reproduction of recommended plantain (AAB) to farmers continues at the Corozal AES. Collection was renovated in June 2022 with 18 accessions, including two new entries, Curare and FHIA20. The banana (AAA) collection was renovated in June 2020 with 26 accessions. The accession FHIA02, a Black Sigatoka resistant variety, is being evaluated for its response to nematodes. PI: Dra. Martha Giraldo.

Root Crops The Sweet potato (*Ipomoea batatas*), Tanier (*Xanthosoma sagittifolium*), Yam (*Dioscorea* spp.) and Cassava (*Manihot esculenta*) were renovated in August 2021 at the Isabela and Corozal AES. Root germplasm requests by farmers are increasing. PI: Dra. Martha Giraldo.

Coffee The Adjuntas Agricultural Experiment Station have been working in the introduction, increase, evaluation, conservation, and distribution of coffee varieties with major characteristics with potential for the coffee production in the Island for more than sixty years. In 1994, two main varieties, "Limani" and "Fronton", displayed rust (*Hemileia vastatrix*) tolerance and superior organoleptic characteristics than the commercial varieties, were released by the AES. This varieties came into Puerto Rico in a group of approximately a dozen of cultivars and advance genotypes claimed as coffee rust resistant from the "Instituto Agronómico de Campiñas" – Brasil in 1982. This genetic material was included in the Puerto Rico collections under study. Two superior genotypes were selected and named as "Limaní" and "Fronton". Limaní, comes from LC-1665= Villa Sarchi x Hibrido Timor HdT CIFC 832/2 better known as Sarchimor and Fronton comes from LC-1661-1= Caturra x Hibrido Timor CIFC 832/1 better known as Catimor. The Coffee Rust (Hemileia vastatrix Berk y Broome was reported in Puerto Rico in 1989. Limaní and Fronton were releases in 1994 with the local names.

As a result of the DNA research performed in 2021, the AES has a genetic data base of the 36 accessions conserved in the coffee collection as coffee rust-resistant material. Limani variety has four (4) unique

genotypes and Fronton variety has one (1) unique genotype with different genetically stable promising rust resistant characteristics. This promising material was selected to extend the study at field level at the AES, Adjuntas. Seeds are under germination and will be transplanted to plastic pots in October 2022. Plants will remain in a plant nursery for approximately 9 months before establishing the field plots for the morphological and phenological evaluation. This will take four years. Rust resistant traits, yield and quality of coffee will also be recorded. The propagation and distribution of Var. Limani and Fronton was reestablished since 2021. PI: Prof. Carlos A Flores Ortega.

South Carolina
Richard Boyles, Clemson University

Germplasm Received from the Plant Genetic Resources Conservation Unit, Southern Regional Plant Introduction Station, Griffin, GA:

Germplasm from five genera was received that represented 10 different research requests in SC during the 2021 calendar year.

The number of individual 2021 germplasm requests were down again by nearly 50% (10 from 19) from 2020; yet, the total number of accessions increased again, this time by over 50% (1,428 from 926). A trend of fewer, but larger requests has arisen in recent years.

This trend seems to also focus on select genera that are being actively evaluated by USDA and academic scientists. Results were dominated by large requests in pepper, sorghum, and sweet potato. For sorghum, two large requests were made by Clemson University scientists in the Boyles Cereal Grains Breeding and Genetics Lab (432 accessions) and Sekhon Genetics and Biochemistry Lab (367). The Boyles Lab requested a RIL population from the larger RTx430 NAM population developed by Kansas State University for characterization and genetic mapping of resistance to fall armyworm (USDA NIFA AFRI grant no. 2019-05269). The sorghum accessions requested by the Sekhon Lab were selected for a continued evaluation of genetic and physiological diversity for field senescence and stalk strength. Peanut accessions were requested by the Rustgi Lab at the Clemson Pee Dee Research and Education Center in Florence to 1) test genotypes for immunogenic seed protein content (PI261942, PI276235, PI270806, PI290620, and PI587093) to breed reduced-immunogenicity peanut genotypes as a source of affordable oral immunotherapy and 2) validate the embryogenic potential of selected peanut genotypes (PI478787 and PI587093) evaluate their potential as an explants source for genome editing and genetic transformation studies. Dr. William Rutter at the USDA-ARS Vegetable Lab in Charleston requested and received 274 accessions (59 *Solanum* species and 215 *Capsicum* species) to screen for root-knot nematode (*Meloidogyne enterolobii*) resistance as *M. enterolobii* is a serious pest of many vegetable crops, with no known sources of resistance to this nematode in any solanaceous vegetables. Any resistance found in these PIs will be incorporated into new pepper or eggplant lines that will serve as valuable management tools for growers in tropical and sub-tropical regions around the world where *M. enterolobii* is a problem. Dr. Phil Wadl at the USDA Vegetable Lab requested 258 sweet potato accessions to also evaluate for resistance to root-knot nematodes as well as measure agronomic performance and level of resistance to fungal diseases.

Tennessee
Virginia Sykes, University of Tennessee

Over the past three years (2019 – 2021), 311 accessions were requested from the PGRC unit at Griffin by individuals in Tennessee. Of these, 201 were requested in 2021, 23 were requested in 2020, and 87 in 2019. Material was requested from 11 genera: Abelmoschus (11), Capsicum (5), Citrullus (4), Cucurbita (3), Desmanthus (1), Indigofera (33), Panicum (1), Solanum (2), Sorghum (3), Trifolium (55), and Vigna (192). Most accessions requested in 2021 (246 out of 311) were from public universities, including the University of Tennessee and Tennessee State University. No publications or germplasm/variety releases related to these accession requests have been reported since the last S-009 report in 2021.

Texas
Gerald R. Smith, Texas A&M University

Multiple Texas seed companies evaluated sorghum germplasm for disease and insect tolerance, forage production, forage quality and other traits. These private breeding programs are looking at both grain and silage sorghums for sugarcane aphid tolerance, disease resistance and resistance to lodging.

Evaluation and breeding continues on forage and multi-use cowpea for Texas. Evaluation of breeding lines and PI lines of cowpea continued at Texas A&M AgriLife, Overton. A new forage cowpea cultivar , 'Giant', was released by Texas A&M AgriLife Research. Elite lines from crosses between high seed yield lines and 'Ace' forage cowpea were advanced and entered into experimental line seed increases. Germplasm lines of black gram were evaluated for root-knot nematode resistance with most lines noted as very susceptible. Research on cowpea and guar continues at Texas A&M AgriLife, Vernon, TX.

Six cultivars of vegetable cowpea were evaluated at Pleasanton, TX by a private seed company. The company's internal research objective was to utilize the germplasm PI lines to increase seed stock for purity while comparing to internal seed lots. The cultivars included were Coronet, Zipper Cream, Texas Cream 40, Mississippi Silver, Cream 12 and Pinkeye Purple Hull-BVR.

U.S. Virgin Islands – No report submitted

Virginia
Bastiaan Bargmann, Virginia Tech

Several institutions in Virginia have used germplasm provided by the S-009 project over the last three years for educational purposes as well as differing lines of research, some with promising results that are expected to lead to publications in the near future. There were no publications reported in the last year. Of the 21 Virginia users, we had a response from six, two email addresses were no longer in use, and 13 did not respond after repeated solicitation.

Dr. Sierra Beecher at Virginia Commonwealth University used *Panicum amarum* seeds to look at germination rates in an educational setting. Dr. Harbans Bhardwaj at Virginia State University used *Phaseolus*, *Vigna*, and *Vicia* germplasm in Virginia to evaluate preliminary production potential of these crops. Reece Crump (affiliation unknown) wanted to use *Cuscuta indecora* and *Cuscuta pentagona* seeds for a breeding experiment with native parasitic plants in the area but reported difficulties in getting them to germinate. Edmund Frost at Common Wealth Seed Growers used squash, cucumber and watermelon seeds to include in research trials, which are focused on identifying and creating varieties that have exceptional adaptation for Virginia and for the Southeast and mid-Atlantic regions more broadly. David Lawson at MountainRose Vinyard used grapes from UC Davis to test long term viability of several

varieties for use in winemaking in his local region of the state. Dr. Bingyu Zhao at Virginia Tech evaluated the disease resistance and flowering time phenotype of requested *Capsicum* germplasms.

Peer-Reviewed Publications

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Germplasm Releases and Patents

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Eggplant 'Ideal': Open-pollinated local cultivar in Guam.

Okra, Puerto Rico Everflush, released by the Utopian Seed Project though the Southern Exposure Seed Exchange in early 2022.

Smith, G.R. 2021. Ace Forage Cowpea. PVP Registration Certificate. PVP#201900266

Zoysiagrass (XZ 14069, commercial name LOBO™) and one St. Augustinegrass (XSA 11377, commercial name TBA) cultivars were released in spring of 2022.

Other Publications

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