Project Number: S-009

Project Title: Plant Genetic Resources Conservation and Utilization

Period Covered: 08/2013 through 8/2014

Date of this Report: September 17, 2014

Annual Meeting Dates: July 22 – July 23, 2014

Participants: www.ars.usda.gov/Main/docs.htm?docid=9514

Minutes: www.ars.usda.gov/Main/docs.htm?docid=9514

Accomplishments and Impacts:

USDA – Plant Genetic Resources Conservation Unit

Plant genetic resources collected or obtained from throughout the world are valuable sources of genetic diversity for use in agronomic and horticultural crop improvement programs in the U.S. This project forms part of a comprehensive nationwide program, National Plant Germplasm System, to preserve plant genetic resources for use today and for use by future generations. The primary objectives of this project are to 1) acquire and conserve genetic resources of crops and related wild species of importance to the Southern Region such as sorghum, peanut, watermelon, chili peppers, warm-season grasses, cowpea, clover, tropical/subtropical legumes, and others; 2) conduct genetic characterizations and phenotypic evaluations of the conserved crops and related wild species for commercially important genetic and agronomic traits; 3) incorporate characterization and evaluation information into the Germplasm Resources Information Network (GRIN-Global) or other public databases; and 4) distribute genetic resources and associated information to researchers, educators, and plant breeders in the Southern Region and worldwide.

Seed and clonal genetic resources acquired, maintained, characterized, evaluated, documented, and distributed by this project will provide researchers with a broad range of clearly-identified crop genetic diversity to utilize. This broad genetic diversity enables research programs to efficiently produce new cultivars, develop new knowledge, discover value-added uses, and preserve food security for the general public.

This project has grown from 811 accessions of 41 genera in 1949 to one of the largest collection of the four NPGS regional multistate projects with 92,201 accessions of 261 genera and 1,558 species in 2013. In 2013, a total of 32,958 seed, tissue culture, and clonal accessions were distributed to researchers and educators at universities, private companies, agricultural and medical research foundations, seed conservatories, federal agencies, farmer-owned cooperatives, and foreign universities and companies. All accessions were requested from the Griffin location directly by researchers and distributed in 1,090 orders to users in 47 states and 40 foreign countries with 13,685 accessions distributed to users in the Southern Region. Genetic resources maintained at the Griffin location are in great demand by the research community and provide a valuable resource for crop improvement research. The quantity and quality of plant genetic

resources maintained at Griffin make this location one of the leaders in the National Plant Germplasm System.

Peanut:

Seed increases were conducted for 1,800 cultivated and wild peanut accessions by Noelle Barkley, Plant Genetic Resources Conservation Unit, in association with ARS and university cooperators with regenerations at locations in Tifton GA, Raleigh NC, Stillwater OK, and Citra FL. Standard descriptor data was recorded for the accessions regenerated. Additional, digital images of accessions were taken for 600 pods and seeds, 1,250 plots and whole plants, and 350 flowers. Images of peanut plots and whole plants capture the variation that exists in the germplasm and together with pod and seed pictures provide a catalog on the genetic variation of each accession. A total of 30 peanut accessions from India and Canada were processed through quarantine and were available for research use. A total of 38 wild peanut accessions were received from two U.S. peanut researchers and added to the collection. The peanut core, mini collection, and commercial standards are being evaluated in the field at Citra, FL, for multiple morphological, genetic, and biochemical traits over a two year period. Molecular markers are being utilized to analyze the genetic diversity as well as associate markers with the traits evaluated in the field. Digital images of seeds, seed weight, and seed color data were taken on 933 peanut accessions during oil content evaluations. Genotype by sequencing was conducted on 72 peanut accessions to evaluate genomic diversity, relationships among individuals, and develop new SNP markers.

Grasses:

A total of 74 warm-season grass accessions were regenerated and submitted to seed storage for long term preservation by Melanie Harrison, Plant Genetic Resources Conservation Unit. Basic descriptor data and 155 plot\flower images were collected and submitted for upload to GRIN for accessions grown in the field. Long-term maintenance of 384 warm-season grass clonal accessions was continued in the greenhouse with napiergrass accessions maintained in the field. The clonal grass collection was reduced by removing redundant accessions, forming crossing blocks to obtain seeds from closely related clonal accessions, and removing clonal accessions that have existing seed in the collection. Native warm-season grasses are currently of interest to users for habitat restoration, biofuel use, or ornamental use. Reduced genetic diversity of switchgrass germplasm limits the ability of plant breeders to develop improved cultivars for bioenergy production. ARS researchers at Griffin, GA, collected a total of 48 switchgrass accessions from diverse habitats and geographic locations in Alabama, Florida, Mississippi, Louisiana, Texas, and Arkansas and processed these accessions into the U.S. switchgrass collection. These collections will provide valuable germplasm needed for switchgrass breeding and research programs. Three ornamental cultivars were extensively phenotyped and documented for patent application. Over 700 plants from crosses of little bluestem and 26 accessions of other warm-season grasses are being observed for potential ornamental value. In collaboration with ARS scientists in Tifton, GA, SSR markers were developed for use in little bluestem and the entire little bluestem collection was genetically characterized.

Clovers, Vigna, New Crops, Misc. Legumes, and Misc. Crops:

Brad Morris, Plant Genetic Resources Conservation Unit, served as the Vigna, new crops, misc. legumes, and misc. crops curator and Gary Pederson served as the annual clover curator.

A total of 101 legumes, sesame, and castor accessions and 63 *Vigna* accessions were regenerated in Griffin GA or in the field in Puerto Rico. Eleven *Aeschynomene* accessions were successfully regenerated in an aeroponic system in the greenhouse. An alternative regeneration technique using hydroponics was used to regenerate four accessions of *Lallab purpureus, Clitoria ternatea,* and *Vigna unguiculata.* Additionally, six Chinese water chestnuts and five *Catharanthas roseus* accessions were regenerated in hydroponics. A total of 55 annual clover accessions were regenerated in the field and greenhouse. Genotype by sequencing was conducted on 125 *Vigna* accessions to evaluate genomic diversity, relationships among individuals, and develop new SNP markers.

Sorghum:

Gary Pederson, Plant Genetic Resources Conservation Unit, is serving as acting sorghum curator. Regeneration of sorghum accessions in St. Croix and Puerto Rico continued in coordination with ARS cooperators, Ricardo Goenaga and Alfredo Quiles. A total of 1,260 accessions were sent to St. Croix for regeneration in 2013 and seed from regenerations of 1,244 accessions have been sent to Griffin. Additional regenerations of four wild sorghum accessions with low seed amounts were being conducted by university cooperators in Texas. University cooperators in California were helping identify 161 unknown accessions to the proper *Sorghum* species. A recombinant inbred population of 226 sorghum accessions was added to the collection from ARS researchers in Lubbock, TX.

Vegetable Crops:

Bob Jarret, Plant Genetic Resources Conservation Unit, regenerated 90 vegetable accessions including *Capsicum* spp. (24), *Citrullus* spp., (40), misc. cucurbits (8), *Ipomoea* spp. (3), *Solanum* spp. (10), and *Abelmoschus* spp. (8). A total of 740 sweetpotato accessions were maintained in tissue culture. A total of 43 *Citrullus* and 5 cucubit accessions were regenerated by industry cooperators in California and added to the collection. The entire sweetpotato collection was provided to ARS researchers in South Carolina for extensive phenotypic characterization. Forty chile pepper accessions known to be infected with pepper mottle mosaic virus were increased in the greenhouse with non-infected seed produced for distribution. Several non-cultivated *Citrullus* species related to the cultivated watermelon are native to a desert environment and are extremely drought tolerant. The anatomical and physiological characteristics of those species that contribute to that drought resistance are not well understood. ARS researchers at Griffin, GA evaluated various morphological characteristics of the vegetative parts of plants of these wild species for their anatomical variation in order to identify characteristics that might be correlated with their extreme drought tolerance. Leaf thickness in *Citrullus ecirrhosus*, a perennial species, was significantly greater than in the other species, but other characteristics examined were not different. Knowledge of the relationship between specific anatomical and physiological characteristics and drought tolerance would facilitate the utilization of those traits for crop improvement.

Biochemical and Molecular Evaluations:

Ming Li Wang, Plant Genetic Resources Conservation Unit, determined seed oil content and fatty acid composition for 25 accessions of five *Desmodium* species and 80 accessions of five *Solanum* species including eggplant. Total oil content was collected on 933 cultivated peanut accessions this year for a total of 4,300 peanut accessions quantified for oil content. Two

peanut accessions were identified with seed oil content over 54% and one of these is being utilized in university breeding programs. Leaf protein content was quantified for 95 bamboo accessions and amino acid composition is being determined. One bamboo accession was identified with leaf protein content over 18%. The oil content and fatty acid composition was completely quantified for the entire sesame collection of 1,232 accessions. Two sesame accessions with over 64% oil content were identified. A sesame mutagenesis project has been initiated with one of these accessions using EMS and 1,200 M_2 mutant lines have been obtained. M_3 seeds will be collected from M_2 plants for selection of lines with high nutritional quality.

Germplasm Maintenance:

A new 4C seed storage facility was completed and an existing 4C facility was converted to -18C freezer storage. This storage space enabled almost 5,000 more accessions to be stored at -18C. Currently, 19% of the accessions are maintained solely at -18 C and 80.1% of the accessions (72,761 accessions) have at least one inventory in -18C long-term storage. Most plant genetic resources in genebanks are maintained under short-term (4C) rather than long-term (-18C) storage temperatures, which increases the need for frequent seed regeneration that can reduce genetic variability. At Griffin, GA, original seed and seed of species rarely requested are maintained solely at -18 C. Other accessions are maintained as split samples with the bulk of the seed maintained at -18 C and a small distribution sample maintained at 4 C. When needed, seed will be removed from the -18 C sample to replenish the distribution sample. These plant genetic resources will remain viable longer with reduced need for regeneration and better retention of genetic variability of the original sample for users.

Prior to 2002, seed samples of over 84,000 accessions of plant genetic resources maintained at the Griffin location had not been tested for germination, and the quality of seed distributed to researchers was not known. A concentrated effort was made to conduct germination tests on this large collection. Currently germination tests have been completed for 79,439 accessions (87.4% of the collection) including almost all available accessions of most crops maintained at Griffin. Viability of most crops (sorghum, cowpea, mung bean, watermelon, okra, eggplant, cucurbits, legumes, annual clover, pearl millet, and sesame) was very good for most accessions in these collections. Warm-season grass, pepper, and peanut collections have several accessions with low viability. This germination testing enables curators to properly identify accessions with poor quality seed that need to be regenerated resulting in better quality seed being distributed to researchers upon request. The germination lab participated in an Association of Official Seed Analysts (AOSA) referee germination duration and cold testing evaluation for sorghum germination with testing of 12 lots of sample seed provided by AOSA.

Biosecurity and availability of plant genetic resources are of major concern to the U.S. agricultural research community. Preserving germplasm by maintaining accessions at two sites reduces the risk of losing valuable germplasm. A total of 89,556 accessions (97.1% of collection) have been deposited for safety back up at the National Center for Genetic Resource Preservation, Ft. Collins, CO, and 88.3% of the accessions are available for use by the research community. Additionally, 10,276 accessions (11.3% of the collection) are also backed up at the Global Seed Bank in Svalbard, Norway. Backing up safely secures these plant genetic resources for future use by researchers and good availability provides users with a wide array of currently available germplasm.

Florida

The state of Florida was very active in 2013 for plant genetic resources distribution. According to records provided by S-9, 40 different individuals requested materials from 17 different genera of plants and a total of 293 unique PIs distributed. Affiliation of individuals obtaining materials included University of Florida scientists, USDA scientists, private research organizations, private citizens, and public schools. Most individuals who responded to a request for information indicated a high level of satisfaction with materials provided and appreciation for the availability of the germplasm. Listed below are reports submitted by cooperators.

Pamela Boye reported the following - We are a public high school in Brevard County Florida. I wrote a grant Project G.R.O.W. (Goals Reached Our Way) and received some start up money to start a garden project with our 4 special education classrooms. The 35 students in those classrooms range from moderately mentally and physically handicapped to profoundly mentally and physically handicapped. Thanks to your germplasm system we were able to not only purchase plants from a local nursery but also see the entire life cycle of a plant from seed to harvest. We ended up with a late fall garden and a spring garden as well. Some of our endeavors were more successful than others....due to our inexperience and variations in depth of planting beds, soil amendments and water conditions. We thank you for your contribution to our first year of Project G.R.O.W. and for enhancing our grant.

Dr. Patricio Munoz provided the following report on annual ryegrass and bermudagrass. Both projects are in collaboration with other scientists.

The objective of the annual ryegrass trial is to characterize the variability of the GRIN collection under Florida conditions. This is part of the dissertation of a graduate student, Esteban Rios. An experiment was planted fall of 2013 from the GRIN collection. We evaluated different traits, including flowering, morphology, yield, among others. Additionally, ploidy level of each PI was determined using flow cytometry. We expect to publish these two studies in 2015.

The objective of the bermudagrass program is to evaluate the variability of the GRIN collection under Florida conditions to select material for starting a breeding program. The entire *Cynodon* germplasm collection was acquired from GRIN and the plan is to evaluate spread capacity, yield, disease, pest tolerance and quality. We are establishing 3 more experiments with the same material in Marianna and Ona, Florida, and in Tifton, Georgia. We expect to publish this study in 2016.

Dr. Ellen Pong made a request in 2013 that included germplasm for several tomato accessions and one sample for PI 264281 *Capsicum annuum*. The request for the tomato germplasm was denied, as the person who gave me this news evidently thought I was trying to get free seeds and recommended several major seed vendors. I did receive PI 264281 *Capsicum annuum* in the late summer, and am very grateful for use of this germplasm. I have planted PI 264281 *Capsicum annuum* this spring 2014, and my first goal is to increase my seed stock before performing my planned crosses. Disease and insects/nematodes are rampant in the Florida Panhandle, and I do not want to risk using all of my germplasm seeds only to have my crosses fail. So 2014 is seed saving to build germplasm stock and 2015 will be cross breeding.

Dr. Greg MacDonald is assisting to evaluate peanut yield, grade and biochemical data from the USDA peanut core collection – regeneration, evaluation and characterization study. Peanut yield and grade were taken from 1098 plot samples comprising 687 core cultivars, 107 mini-core cultivars (3 replications each) and 14 commercial varieties (3 to 9 replications each). Cultivars ranged widely in terms of yield, while most commercial lines exhibited typical grower yields. Grade was also variable, but most cultivars showed >65% total sound mature kernels. Seeds from the 321 peanut mini-core standard lines (107 lines x 3 replications) were assayed for

total oil, fatty acid composition and protein content. In addition, 14 commercial lines comprising high oleic and non-high oleic peanut cultivars were assessed. Tissue was coarse ground using a coffee grinder and then pulverized using a mortar and pestle with liquid nitrogen. Protein content was determined spectrophotometrically using the Bradford assay compared to known standards. Oil was extracted, esterified and analyzed using gas chromatography. Most cultivars ranged from 25-35% protein and 45-60% oil. Most cultivars did not exhibit the high-oleic acid oil profile. Biochemical data from the remaining 687 core cultivars is currently being assessed.
Mr. Robert Beiriger reported the following - We continue to work with the older germplasm we received. We have crossed these lines to some of our inbred lines and population and are now in the F 2-5 stage of selfing these crosses in an attempt to produce good disease resistant, high yielding inbreds. Some of the these lines did show good resistance to southern rust this spring while producing good quality plants, good ear and yields. We plan to continue to self these lines in the future.

We recently received 38 European Corn Borer resistant lines which we tried to evaluate for Fall Army Worm resistance. We did not have much worm pressure so we were not able to complete this test. We did increase these lines and plan to attempt this in the future.
Dr. Ken Quesenberry forage and turf breeder in the Agronomy Department, Gainesville reports that further grazing evaluation of eight selected superior F1 hybrids from *Hemarthria altissima* crosses of PI 299995 (Bigalta) and PI 364888 (Floralta) has resulted in identification of two superior lines that were approved for release by the FAES in April 2014. Planting material of these two hybrids will be distributed to selected growers in August 2014. Dr. Quesenberry in cooperation with Dr. Ann Blount and Dr. Kevin Kenworthy is continuing evaluations of new apomictic forage bahiagrass hybrids and of other bahiagrass accessions that may have potential as utility turfgrass. A group of 12 superior selections have been identified and further research will be conducted focused on seed production and alternative vegetative propagation methodologies. Additional vegetative planting material of the Arachis glabrata cultivars UF-Peace (PI 6582140 and UF-Tito (PI 262826) was distributed to growers in spring 2014, and is being increased for further producer planting. Dr. Quesenberry is also evaluating pollination biology of the rare *Trifolium* species, *T. acuale* (no PI assigned – From N.L. Taylor collection), *T.andricum* (no PI assigned – From N.L. Taylor collection), and *T. wigginsii* (PI 615075).

Eric von Wettberg reported on his use of *Vigna* PIs. He collected preliminary data on early seedling growth across the genus. It was successful preliminary data, but he has decided to not pursue writing it up or writing a proposal based on that data at this time. It was a minor use, but he definitely found the material extremely useful and plans to come back to it in 3-5 years when my current funding on chickpea runs out.

Mr. Jeff Fedenko, PhD student in the UF Agronomy Department reported that germplasm was requested for three different projects. Project one involves a comparison of growth and water use under field conditions between two sorghum cultivars which differ primarily in leaf orientation. Project two was a comparison of 10 sunflower accessions grown over the summer in North Florida. Seed oil content, seed head production and yield per plant, and plant height were quantified. Across genotypes, seed head abundance and head size were not correlated. Significant insect and disease damage was observed in all accessions. Project three is a comparison of seed oil content across members of the *Brassica* and *Camelina* genera.

Dr. Vance Whitaker reported on strawberries that during the last calendar year, the University of Florida strawberry breeding program has utilized wild strawberry species in population improvement efforts. Wild accessions include those from *Fragaria virginiana* and *F.*

chiloensis sourced from the USDA National Clonal Germplasm Repository (NCGR) in Corvallis, OR. The first major effort in the past 12 months has been in crossing with elite UF breeding selections to introgress important traits such as day neutral flowering, heat tolerance and disease resistances. Some introgression efforts have reached the BC2 stage. The second major effort has been in screening wild species for resistance to an important disease in Florida, crown rot caused by *Colletotrichum gloeosporioides*. A student has identified a wide range of resistance, with some accessions of *F. virginiana* being highly resistant, with zero plant death in inoculated field trials.

Dr. Mehmet Oztan provided the following report: I received three accessions from the Plant Genetics Resource Conservation Unit at Griffin, GA, last fall to be grown as part of the Anatolian Heirloom Seeds Recovery Project (ANATOHUM). The project has a bi-lingual (both in English and Turkish) database available at http://anatohum.com and I have uploaded the information/initial observations for these accessions to the database. To make the classification easier, all accessions are given variety names (if none exists or if no such information is available). You can view the project results for:
PI 173827: http://anatohum.com/phpBB3/viewtopic.php?f=72&t=96
PI 503328: http://anatohum.com/phpBB3/viewtopic.php?f=72&t=94
PI 560505: http://anatohum.com/phpBB3/viewtopic.php?f=72&t=95
Anathhum Project's current goals are given below:
1) To create an informative online database of Turkey's edible plant varieties.
2) To increase the circulation of the valuable and rare Turkish varieties by propagating seeds for distribution.
3) To observe the performance of the requested varieties in local (FL) conditions.

Enough seeds were propagated for PI 503328 to distribute to the project volunteers in the US in different hardiness zones. One set of seeds for this accession will also be sent to the Plant Genetics Resource Conservation Unit at Griffin, soon, to replace the original seed stock. PI 173827 and PI 560505 are still in production and a replacement for these accessions will also be sent to the unit. We had a challenging fall season in 2013 and some of our crops failed so it takes time to evaluate all accessions at once. The project database is dynamic and updates are implemented to each accession's entry as more feedback on varieties becomes available.

Furthermore, another set of seeds for PI 503328 will also be shared with a small produce farm in Bushnell, FL, as this accession has potential economical value in terms of agricultural production. This will also give the opportunity to evaluate the accession further in Florida's growing conditions. Evaluating these and more accessions will also give the project the chance to also bring out the ones which are promising for future breeding efforts.

All accessions are organically grown on an urban farm located in Tampa, the Dancing Goat. The Dancing Goat is a very good example of sustainable farming and we fully benefit from the goat manure, recycled mulch and other resources that the farm offers. The project is not yet supported by grants but its expenses (e.g. organic fungicides and pest management products, other organic growing materials etc) are privately funded.

Please let me know if you have any questions and/or need further information from me. I look forward to working with the conversation unit in the future towards building the Anatohum Project's informative/educational database and recovering/preserving Turkish heirloom varieties.

Dr. Kevin Kenworthy, University of Florida, turf and forage breeder in Agronomy reported that a significant evaluation effort on mutagenic bahiagrass continues regarding mutagenic lines of apomictic Argentine and Wilmington bahiagrass. A significant effort

continues in the breeding of St. Augustinegrass and zoysiagrass for improved turfgrass performance in Florida and reduced susceptibility to large patch. The breeding of seashore paspalum continues to progress to develop finer textured lines that are less susceptible to dollar spot. The bermudagrass program continues to breed for improved responses to the sting nematode with PI 291590 showing positive responses for further evaluation.

Dr. Ann Blount, University of Florida, North Florida Research and Education Center, Marianna, FL reports the following.

Bahiagrass evaluation: Bahiagrass (*Paspalum notatum*) germplasm evaluation continues in Florida with approximately 45 plant introductions from NPGS-GRIN, Australia, Uruguay and Argentina in multi-year and multi-location trials. Winter hardiness, drought tolerance and seasonal distribution of forage production are main objectives in screening and evaluation. Species with superior winter hardiness and active winter forage production when compared to bahiagrass includes *P. cromyorhizon*, *P. guaraniticum,* and *P. nicorae*). Selections and novel populations are in seed increase in 2014. Traits evaluated include winter survival, frost tolerance, forage yield, forage quality, seasonal forage distribution, turf characteristics, seed production, and defoliation. NPGS-GRIN germplasm in this evaluation includes *P. notatum*, *P. nicorae*, *P. quadrifarium* and *P. guaraniticum* (*P. nicorae* - PIs 202044, 209983, 276248, 276249, 283020, 284171, 304004, 310131, 404469, 404471, 404859, 462273, 477103, 490363, 490364, 508818, 508819, 508820, 508821; *P. quadrifarium* - 404880, 404881, 404882, 462302, 462295, 462298, 508942, 508947; *P. guaraniticum* – 404449). Several plant introductions have persisted at the USDA-ARS Subtropical Research Station at Brooksville, FL. Seed increases of these lines are currently grown at the NFREC-Marianna, FL.

Arachis glabrata evaluation: Approximately 108 perennial peanut PI cuttings were obtained from Roy Pittman, USDA-ARS-Griffin in 2009. These plant introductions were established in the field/greenhouse in 2009-2010. Evaluation of these PIs will include winter survival, frost tolerance, foliage yield, seasonal foliage growth, turf or forage classification, flowering aspects, shade tolerance, and persistence under clipping. Twenty of these PIs and Griffin introductions have been selected for further evaluation. Purification of these germplasm has been made from single vegetative cuttings. Naturally occurring off-types proliferate many of these introductions and plant selection for aggressive growth habit under non-irrigated and low-fertility conditions has been a key selection trait. Disease resistance to fungal and viral pathogens has also been evaluated. Release of two plant introductions is under consideration for 2014. Additionally, 38 "Gregory hybrids", crosses made between *Arachis* species and *A. glabrata* X *A. glabrata*, were obtained in 2013 from the USDA-ARS Griffin Station. These plants have been vegetatively increased in the greenhouse at the NFREC-Quincy and will be field planted in 2015 for evaluation.

Hemarthria evaluation: Plant introductions of *Hemarthria* were planted under non-irrigated conditions at the North Florida Research and Education Center at Marianna, FL and include: PIs 299039, 299993, 299994, 299995, 349750, 349751, 349752, 349754, 349796, 364861, 364863, 364865, 364868, 364869, 364871, 364874, 364875, 364876, 364877, 364878, 364881, 364882, 364884, 364885, 364890, 364891, 365145, 379613, 383331, 409751, 410128, 410129, 410131, 410132, 410133, 410134, 410137, 410138, 410139, 410140, 413186, 508606. BYDV has been documented on the limpograss PIs. Novel hybrids of limpograss resulting from crossing PIs are being evaluated for cold tolerance, and improved forage quality. These effort has resulted in the release of two new hybrids, 4F ("Kenhy") and 10 ("Gibb Tucker"). Continuing the evaluation of hemarthria will focus on crude protein and cold tolerance.

Gamagrass evaluation: Twenty eight Florida gamagrass (*Tripsacum dactyloides*) selections collected by NRCS and forage breeders at University of Florida are under evaluation at the NFREC. These include NRCS nos. 9055975, 9056065, 9056073, 9059196, 9059199, 9059203, 9059215, 9059232,9059254, 9059267, 9059269, 9059272, 9059280, 9059281,9059282, 9059283, 9059285, 9059286, 9059287, 9059290, 9059294, 9059338, and NFREC ecotypes Joe Budd, Rancher, Pine Acres, Woodruff Dam, Marianna and Savannah. New NRCS gamagrass experimental lines were established at the NFREC-Marianna in 2008-2009 and seed increases of these have been made annually. Additionally, NRCS 9059266 was planted in 2009 and 2010 in seed increase plots at the NFREC-Marianna site. This line, referred to as "Florida Gama", is slated to be released jointly by NRCS and UF in 2014.

Aristida stricta collection: A southeastern collection of wiregrass (GA, FL and AL) has been planted at the NFREC-Marianna as part of a cooperative arrangement with Northwest Water Management District-FL, NPGS-Griffin, NRCS-PMC-Brooksville and NFREC-Marianna to collect and evaluate populations of wiregrass and submit new germplasm to NPGS-GRIN. Currently the collection houses about 20 ecotypes.

Georgia

During 2013, seventy-three different requests for plant germplasm were made to the S-009 unit by citizens of Georgia. As a result of these requests, 361 plant accessions were supplied to University scientists, USDA scientists, consultants, seed companies, gardeners, and citizens of Georgia. The most requested crops were sorghum, pepper, peanut, warm-season grasses, sweet potato, cowpea, and watermelon.

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 currently has 34 faculty members and 24 graduate students as well as many research scientists, 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.

UGA currently has active cultivar development programs in soybean, peanut, small grains, cotton, turf grasses, forages, blueberries, pecan, grape, and numerous ornamental crops that frequently utilize the plant genetic resource collections. These cultivar development programs have released 24 cultivars or crop germplasm lines in the past year (Table 1).

Research programs in crop science, horticulture, plant pathology, entomology 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.
Projects currently underway involving the S-009 germplasm include:

1) Evaluation of the entire available seashore paspalum (warm-season turfgrass) collection for salt tolerance and the development of molecular markers that could be used by breeding programs to improve salt tolerance in grasses.
2) Evaluation of seashore paspalum assessions for tolerance to dollar spot disease (*Sclerotinia homoeocarpa*)
3) Evaluation of a large portion of the zoysiagrass germplasm collection for salt tolerance.
4) Identification of genes and pathways involved in Cucurbit disease resistance.
5) Identifying QTLs associated with important traits in watermelon.

6) Translational genomics for enhancing disease resistance in plants, an internet-facilitated education program for training plant breeders.
7) Inheritance of *P. capsici* resistance in pepper.
8) Genetic analysis of shattering of the sorghum inflorescence.
9) Transmission genetics of *Sorghum halepense* x *S. bicolor* crosses.
10) Genome-wide association study of sorghum growth and development.
11) Ornamental grasses are included in a butterfly, bee, and beneficial insect conservation garden at the Griffin Campus.

In summary, the S-009 unit remains a critical component of our research and cultivar development programs in Georgia.

Table 1. Cultivar Releases from UGA Breeding Programs in 2013-2014

Blueberry TH-917	Soybean G12PR-7R2
Blueberry TH-921	Soybean Germplasm – G07-6012
Blueberry TH-948	Soybean Germplasm – G07-6029
Muscadine GA 1-148	Vitex V0502-33
Ornamental Grass Tift 114	Vitex V0509A-7
Ornamental Grass Tift 125	Vitex V07-2
Peanut C1805-3-43	Vitex V07-SC-OP-4
Peanut GA 072716 (‘GA-13M’)	Vitex Vhet-3kr
Pecan – Selection #121 (‘Tom’)	Wheat GA 031086-10E26
Soybean G06-3182RR	Wheat GA 031134-10E29
Soybean G12PR-54R2	Wheat GA 031257-10LE34
Soybean G12PR-63R2	Wheat GA 04570-10E46

Guam

Plant collection, conservation and distribution:

Musa, *Colocasia* and *Dioscorea*

In-vitro culture of selected lines of banana (*Musa* spp.), taro (*Colocasia* sp.), and yam (*Dioscorea* spp.) were continued for local distribution at Guam Department of Agriculture.

Evaluation of germplasm adaptation to Guam’s climate

Capsicum

Three accessions of chili peppers, PI 593566 (*C. annuum*), PI 241675 (*C. frutescens*) and PI 257051 (*C. frutescens*), were obtained from USDA/ARS/PGRCU Griffin GA. All accessions were affected severely by virus diseases in the field evaluation.

Artocarpus altilis

Clones of breadfruit (*Artocarpus altilis*) ‘Ma'afala’ were planted in the field of calcareous Guam cobbly clay soil on March 20, 2012 for evaluation of its adaptability in Guam. No flowering was observed during the entire year of 2013. Investigation is in progress to examine plant phenology and an occurrence of pest problems.

Tomato *(Solanum lycopersicum)*

Sixteen tomato breeding lines were obtained from the World Vegetable Center (AVRDC) for field evaluation in Guam. These accessions were tomato yellow leaf curl virus disease

(TYLCV)-resistant tomato or cherry tomato accessions. Two groups (tomato and cherry tomato) were evaluated independently in Guam cobbly clay soil in a randomized complete block design with three replications. Nine tomato lines were in one group, and the other group included seven cherry tomato lines plus cv. Season Red, a commonly grown cherry tomato in Guam. In addition to field evaluation at Guam Experiment Station Farm, accessions were planted in a farmer's field during 2013 dry season. Distinct leaf curling symptom was observed for all cherry tomato accessions at both field trials. Eventually regular sized tomato started to show leaf curling. At later stages, some lines showed leaf mottling and discoloration of fruits. Leaf samples were sent to Dr. Kai-Shu Ling, a virologist at USDA, ARS, Vegetable laboratory, Charleston, SC to determine the presence of tomato yellow leaf curl virus of the family Geminiviridae. All germlines have tested positive for a TYLCV Guam strain. Further study will be needed to confirm the stain of the virus, and field trails will be conducted to find resistant cultivars for this disease.

Ironwood (*Causurina equisetifolia*)

Dr. Robert Schlub, Extension Plant Pathologist, conducted a germplasm evaluation of 12 *Causurina equisetifolia* lines to determine the rate of growth and susceptibility to multiple diseases.

Outcomes / Impact:

Regeneration of selected lines of tropical crops for Guam will support the increase in local farming production and diversification of agricultural crops as well as conservation of germlines. Evaluation of important tropical plant germlines will support development of sustainable agriculture in the region. The search for new germlines and commercial cultivars with tolerance and pest resistance will assist growers in choosing locally adapted vegetables and windbreak plants to sustain their manageable farming operation in Guam.

Kentucky

The Kentucky Agricultural Experiment Station approved the release of a new crimson clover cultivar ('KY-Pride'), one of the breeding populations developed by Norman Taylor several decades earlier. This variety has demonstrated improved winter hardiness in KY and begins flowering 5-10 days later than commercially-available cultivars. Increased interest in cover crops in the Midwest prompted Dr. Taylor to resume his testing of this population before his death in 2010. KY-Pride is the name Dr. Taylor proposed for this cultivar.

Recent germplasm requests for material housed at Griffin and sent to KY in 2013 includes sorghum, cowpea, peanut, pepper, and various warm season grasses. A total of 221 accessions were sent to KY in 2013, an increase from 86 accessions sent to KY in 2012. The majority of requests (160 accessions) in 2013 were from George Antonious at Kentucky State University. He has screened pepper accessions for variation in antioxidant content, pungency, and insect resistance in recent years. Studies on winter survival in KY continue to be conducted using several warm season grass species. A few accessions are being used by educators (from elementary school to the University of Kentucky). Mike Harrell's new turfgrass research company requested several Paspalum accessions, and a few other private companies requested accessions of pepper, sorghum, and peanut.

The following table summarizes numbers of accessions from Griffin sent to Kentucky during 2009-2012:

Recipient

Year	University of KY	Other KY	Private/other

		Universities	
2009	38	1	30
2010	4	25	4
2011	83	0	11
2012	66	3	17
2013	29	160	32

Louisiana

Pepper genotypes from the repository are being grown in the greenhouse and screened for the presence of bell pepper endornavirus and related viruses. Two distinct projects focus on sorghum. One is evaluating compatibility with related species and a second project is screening materials for suitability in parental crosses for a sorghum breeding program. Malvaceae family species are being screened for odd-chain unsaturated fatty acids in their seed oils. These fatty acids were identified in the initial accessions and additional accessions will be screened. Additional accessions were screened in 2013. Research on *Ipomoea* accessions focuses on the systematics and evolution of morning glories, specifically members of the tribe Ipomoeeae. A research group is finalizing a phylogenetic study of Ipomoeeae. The material request targeted accessions to broaden taxons or get additional material to further examine taxonomic positions. Additional cultivated *Ipomoea batatas* accessions were obtained through the quarantine system from Uruguay for use in skinning resistance research. High numbers of legumes were requested again for research purposes at Louisiana State University.

Mississippi

Germplasm requested from GRIN during 2013 were used for various research and extension activities. During this past year, ten requests were made from the S-009 Unit by entities in Mississippi. Half the requests were for legumes (excluding peanut), one request for peanut, and the balance were for peppers (*Capsicum*). The plant accessions were supplied to University scientists, USDA scientists, consultants, seed companies, gardeners, and citizens of Mississippi. The most requested crop was pepper. *Lespedeza* species requested were to be assessed as an ornamental. Zydeco Farms propagates culinary peppers.

North Carolina

Plant introductions are critical components of plant improvement at NC State University and all plant breeding programs make use of germplasm maintained in the National Plant Germplasm System (NPGS). Faculty in the Crop Science and Horticultural Science Departments at NC State University conduct research on strawberry, blueberry, brambles, tree crops, ornamentals, maize, soybean, peanut, cotton, tobacco, small grains, turfgrasses, sweet potato, cucurbits, and other crops. Priorities are on incorporating disease and insect resistance, abiotic stress resistance, and quality factors into improved breeding lines and cultivars. The Plant Breeding Center also is supporting a large group of graduate students who are studying plant breeding, many of whom are involved with plant germplasm collections.

The research focus of the cotton program is developing germplasm, genetic stocks, and mapping genomic resources for enhancing the cotton productivity. Interspecific hybrids are being developed to introgress genes for improved cotton fiber quality and yield. Lines with improved yield fiber quality and fusarium resistance have been released as germplasm lines.

The cucumber breeding project at NC State has been working on developing new hybrids of the pickling type for use by North Carolina growers. A program with blackberry and raspberry is attempting to adapt germplasm to North Carolina environments. Watermelon populations with orange flesh, canary yellow flesh, small fruit, high yield, high quality, and gummy stem blight resistance are being selected for use in cultivar development. Breeding is continuing on eastern shipping cantaloupes, sprite melons and canary melons.

The cut flower breeding program is emphasizing efforts to improve zinnias and *Eucomis*. Zinnias are a popular cut flower crop grown widely throughout the U.S. and *Eucomis* is a new crop with potential for the Southeast. Efforts are being made to develop *Z. violacea* cultivars with powdery mildew resistance and cultivars of *Eucomis* with stronger flower racemes to reduce lodging.

The maize breeding program has one state-supported and two USDA scientists. Projects are investigating several Latin American accessions identified in the Allelic Diversity GEM project that failed to set seed as F_1 hybrid females in backcrosses with standard lines. Efforts are being made to study incompatibility factors in U.S. and Mexican maize. These factors have both historic interest and potential economic value. The GEM site at Iowa State, the Panzea site at Cornell, and the maize genetics site at Cornell all have data from the maize program at NC State. In addition, genetic diversity is being investigated using molecular markers for a very large array of agronomically important traits.

Butterfly bush is being bred for compact and sterile forms with reduced or no invasive potential. Traditional cultivars are very vigorous and challenging to manage in a home landscape. Six advanced selections have potential for improved cultivar releases. Raspberries are being adapted to all climates found in North Carolina, with emphasis on superior horticultural traits and long shelf life. Redbud is being bred for weeping and compact forms encompassing the range of leaf variants (purple leaf, variegated leaf, golden leaf) and flower color variants. Hybridization of eastern redbud with Texas redbud is incorporating genes for drought and heat tolerance from the Texas forms into eastern redbuds.

Collections of *Arachis* cultivars and wild species are being maintained in the peanut program. An *Arachis* species collection is being maintained as a backup of the USDA materials and 432 (of the 607 in the USDA collection) accessions are currently propagated. During the past year there were 250 cultivated PIs propagated for the peanut curator. In addition, 212 *Arachis* species accessions are in a field seed-increase nursery and more than 250 plants of *Arachis* accessions are being propagated in the greenhouse for seed increase. During the past year, 90,500 seeds of 81 *Arachis* species accessions were sent to the USDA peanut curator (total of 420,750 seeds of 226 accessions since 2011) to resupply the USDA collection with viable seeds. Seeds of 48 additional *Arachis* species accessions were introduced to NCSU in 2014. We are attempting to document the numbers of wild peanut accessions being maintained at Texas A&M University, CENARGEN in Brazil, and ICRISAT to replace the lost accessions in the USDA collection.

Peanut breeding efforts are being made to pyramid genes for disease resistances into single genotypes, investigate the inheritance of Sclerotinia blight and tomato spotted wilt virus resistances, develop drought resistant genotypes, and higher yields. Both cultivated and wild species are being utilized in the breeding program, and the most advanced breeding lines have a significant amount of wild species germplasm (which confers multiple disease resistances) in their pedigrees. In addition, a multistate project created 6,400 recombinant inbred lines from crosses between two cultivars and eight lines with an array of quality and disease resistance traits. DNA samples were taken from these materials and seed has been increased for storage and distribution.

The soybean breeding program has two USDA scientists who are concentrating on utilizing exotic germplasm to improve drought resistance and to breed for altered fatty acid profiles. Significant progress has been made during recent years to increase yields of non-GMO cultivars**.** The state supported soybean breeding position is vacant and the time frame for refilling the vacancy is uncertain. One of the two USDA soybean breeding positions is also vacant.

Gina Fernandez assumed leadership of strawberry breeding program in 2014. Jeremy Pattison, the former breeder took a position with Driscoll Strawberry in California. The objectives of the strawberry breeding program are to maintain germplasm, select improved genotypes for anthracnose resistance, superior horticultural traits, and different maturity levels.

Research emphasis for sweetpotatoes is to develop disease and insect resistances in table-stock cultivars and to develop specialty-type sweet potatoes with improved root quality. Efforts are being made to improve resistances to insects and pathogens by utilizing wild and/or related plant germplasm as a source of commercially important traits. In addition, the breeding program is selecting ornamental types for urban landscapes.

The U.S. collection of cultivated and wild *Nicotiana* species is maintained at NCSU and numerous seed requests have been received by U.S. and international individuals and organizations. Accessions are no longer being sent out to individuals or companies other than those that support the NCSU tobacco breeding program. The tobacco breeding program continues to develop hybrids for both the flue-cured and burley markets with enhanced disease and virus resistances. Transcription factors in tobacco and its effects on nicotine biosynthesis are also being studied.

The tomato breeding program at NC State University aims to improve tomato fruit quality, disease resistance and stress tolerance by conventional and molecular breeding methods. Current emphasis is to combine resistances for early blight, late blight, fusarium wilt, bacterial wilt, tomato spotted wilt virus, tomato mosaic virus and root knot nematode. Conventional and molecular approaches are adopted to improve the tomato for fruit quality, fruit smoothness, size and color.

The turfgrass breeder is working to improve turf sustainability by developing cultivars that require reduced inputs and that are capable of tolerating biotic and environmental stresses. Specific projects include breeding for drought tolerance in tall fescue, breeding for cold tolerance in St. Augustine grass and bermudagrass, evaluation of St. Augustinegrass germplasm for gray leaf spot resistance, evaluation of zoysiagrass germplasm for large patch resistance, and developing EMS mutants in centipede grass. A turfgrass genetics program has both biotechnology and cultivar improvement components. High throughput transformation protocols were developed for switchgrass and perennial ryegrass, and useful genes have been transferred into these two species.

The wheat breeding program is utilizing wild species to introgress genes for scab and other diseases into the cultivated species. Both breeding lines and cultivars are being released for the North Carolina environment. The Eastern Regional Small Grains Genotyping Laboratory at NCSU is involved in use of markers to characterize germplasm and deployment of genes/QTL by marker-assisted selection.

Tomato breeding targets improving fruit quality, disease resistance and stress tolerance by conventional and molecular breeding methods. The research emphasis is to combine resistances for early blight, late blight, fusarium wilt, bacterial wilt, tomato spotted wilt virus, tomato mosaic virus and root knot nematode. Fruit quality, fruit smoothness, size and color are the traits of interest.

In addition to germplasm and cultivar development, the Plant Pathology Department manages a micro-propagation unit to assure that strawberry and sweet potato germplasm and root stocks are virus free. This unit is critical for maintaining disease-free cultivars in North Carolina.

Cultivar releases

Von – thornless blackberry cultivar
Pinnacle – southern highbush blueberry cultivar
Blue Chip Jr. – Butterfly bush cultivar
Pink Micro Chip – Butterfly bush cultivar
Pink Pom Poms – *Cercis canadensis* cultivar
NCCH1 – interspecific hybrid dogwood cultivar
Sullivan – large seeded peanut cultivar
Wynne – large seeded peanut cultivar
Pyrus (H2004-014-008) – pear tree cultivar
Black Galaxy – ornamental sweetpotato cultivar
Sweet Carolina Copper – vegetable sweet potato
Mountain Rouge – NC08224, Heirloom-type F_1 hybrid tomato

Germplasm releases

NCORNSP-017scc – Ornamental sweet potato germplasm line
NC 161L – pink fruited tomato breeding line
NCAJ1 – tomato germplasm line
GP-NC WS 16 – interspecific hybrid peanut germplasm line
GP-NC WS 17 – interspecific hybrid peanut germplasm line

Oklahoma

Plant germplasm distribution data indicate that 111 plant accessions maintained at the USDA ARS Plant Genetic Resources Conservation Unit at Griffin, GA were distributed to organizations or individuals in Oklahoma. The accessions were distributed in 17 requests. The requested plant germplasm in 2013 included peppers (*Capsicum annuum*) (18 accessions), sorghum (*Sorghum bicolor*) (16 accessions), *Panicum* species (*virgatum*, *amarum, antidotale, bergii, capillare, coloratum, deustum, dichotomiflorum, hallii, repens, trichanthum, and virgatum var. cubense*) (14 accessions), *Pennisetum* species (5 accessions), sweet potato (*Ipomoea batatas*) (2 accessions), peanuts (*Arachis hypogaea*) (2 accessions), *Centrosema virginianum* (1 accessin), and some other warm-season grasses . Receivers of the plant accessions represent researchers of Oklahoma State University, USDA-ARS laboratories, Noble Foundation, an elementary school, and farms in the state. Several individuals also requested germplasm in 2013.

Puerto Rico

Eighteen quenepa cultivars are in the ninth year of evaluation. In 2013 fruit production was poor. In Lajas, 50% of the trees fruited lightly and only 9% had enough fruit to harvest, with an average harvest weight of 69.6 pounds per tree. In Juana Diaz 20% of the trees fruited lightly and only 6% had enough fruit to harvest, with an average of 75.1 pounds per tree. Citrus germplasm collections are being maintained in screenhouses at Isabela and Rio Piedras, and the collections were tested for citrus greening, Citrus Tristeza Virus, and Phytophthora. An evaluation of planting date with 5 yellow fleshed sweet potatoes showed higher yields in the

January planting (18,413 kg/ha of marketable roots) than in September (10,683 kg/ha of marketable roots). 'Canolia' was the best sweet potato cultivar, with a yield of 18,194 kg/ha. Two new banana cultivars (FHIA 2 and FHIA 18) were added to the Musa field collection, and will be evaluated for Black Sigatoka resistance and production. Planting material of 'Maiden' and 'Cuerno de Alce' plantain, and 'Grand Nain' and 'Yangambii' banana was distributed to farmers. A pigeonpea evaluation experiment was established in November 2012 in Isabela to evaluate pod fly resistance from crosses with resistant line l-8-3-1. A field evaluation of 30 rice accessions with 4 replications was conducted under flooded and upland conditions.

Variety trials of historical vegetable varieties were conducted in Juana Diaz:
Okra: 'Puerto Rico Evergreen' in comparison with 'Clemson Spineless' and 'Emerald'
Tropical pumpkin:'Fortuna' in comparison with 'Taina Dorada' and 'Cambalache'
Cucumber: 'P.R. 39' in comparison with 'Ashley', 'Poinsett 76' and 'Marketmore 76'
Fresh market tomato: 'Plamar Caribe' in comparison with 'Beefsteak' and 'Peron'
Cooking tomato: 'Platillo' and 'Petrillo', in comparison with 'Rosso Sicilian' and 'Costoluto Genovese'
Eggplant: 'Puerto Rican Beauty' in comparison with 'Florida Market' and 'Florida Highbush'.

A survey for the detection of *Phytophthora* was conducted in commercial citrus orchards and at three experiment stations. Both *P. nicotianae* and *P. citricola* were identified. Studies on achachairu propagation and resistance to fruit fly are being conducted. Data for growth characteristics of shade grown achachairu seedlings with different growth regulator treatments were collected and analyzed. Ten local breadfruit clones were selected, described, and are being propagated for field trials. USDA germplasm requests in Puerto Rico in 2013 include 1,904 accessions of sorghum, 27 of sweet potato, and 1 of *Chrysopogon zizanioides*.

South Carolina

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

The following list of germplasm was received by 19 different researchers or individuals in SC during 2013.

Genus	# of accessions
Arachis	4
Canavalia	12
Capsicum	18
Citrullus	497
Cucurbita	1
Indigofera	5
Ipomoea	547
Lagenaria	7
Momordica	2
Ricinus	4
Sesamum	1
Sorghum	881
Soybean	16
Vigna	3
Total	1998

Plant Breeding Research at Clemson University

Soybean breeding program (Dr. Ben Fallen, Soybean breeder)

Sixteen plant introductions were used in crossing programs to incorporate genetic diversity into the program, particularly for insect-pest resistances and increased oil and protein content. The insect-pests included foliar feeding insects, soybean looper, velvet bean caterpillar, corn earworm and root-knot nematode. Two other plant introductions, PI 647081 and PI 647082 have three QTLs associated with insect resistances. Additionally, PIs, PI 424444 B, PI 594191, PI 58777 were obtained to develop soybeans adapted to SC with improved oil/ protein content.

Peanut breeding program (Dr. S. P. Tallury, Peanut breeder)

Four plant introductions (PI 478787, PI 556992, PI 562530, PI 591815) with multiple disease resistances and early maturity were used in crossing programs with desirable breeding lines within the program to create segregating populations for field studies.

Germplasm/cultivar releases:

The S.C. Crop Improvement Association Review Board approved four Roundup Ready varieties of soybeans (Dr. Shipe), nine sorghum hybrids suitable for bioenergy (Dr. Kresovich) and eight cotton germplasm lines (Dr. Campbell) jointly released with the U.S. Department of Agriculture research center in Florence. The four soybean varieties are SC04-375, SC03-062, SC04-306, SC06-676. All are glyphosate-tolerant (RR1), high yielding, and some lines offer multiple nematode and disease resistance traits. The nine cellulosic biomass sorghum hybrids included CU-C003, CU-C041, CU-C053, CU-C056, CU-C057, CU-C060, CU-C087, CU-C126, and CU-C225. These hybrids are photoperiod sensitive for use in bioenergy production systems. The cotton germplasm lines are PD 05035, PD 05041, PD 05064, PD 05069, PD 05070, PD 05071, PD 06001 and PD 06078. These eight lines have superior fiber quality, fiber spinning performance and excellent yield.

Tennessee

Row Crops:

Corn

Project Title: Cereal Breeding

Subtitle: Breeding maize lines with exotic germplasm

Personnel: Dennis West, Univ Tenn

Collaborators: Major Goodman, Matt Krakowsky, USDA and NCSU

Objective: Develop improved maize germplasm for the southern region.

Approach: Early generation lines from the Germplasm Enhancement of Maize (GEM) project, expired PVP lines, and other germplasm obtained from the North Central Regional Plant Introduction station maize collection are crossed with elite adapted lines. Progeny from crosses are advanced by traditional breeding methods, to develop new maize parental lines. In 2013 we obtained the following maize germplasm from the NPGS for inclusion in our maize breeding project:

	PI/code	cultivar
1. Lines from the GEM project;	GEMS-0234	-
	GEMS-0235	-
	GEMN-0238	-
	GEMS-0240	-
	GEMS-0241	-
	GEMN-0242	-

	GEMS-0243	
2. Expired PVP lines;	565100	PHAW6
	548803	PHR03
	578029	PHBB3
	564748	MBWZ
	564749	AQA3
	564750	91IFC2
	564755	LH183
	564751	2FADB
	564752	MM501D

SOYBEAN

Project Title: Germplasm Resources for Enhancing Glyphosate Herbicide Resistant Soybean Seed Yield

Personnel: Vince Pantalone, Professor; Chris Smallwood, Research Associate; Ben Fallen, Research Associate; Debbie Ellis, Research Associate; Rachel Fulton, Research Associate; Beth Meyer, Research Associate; Jeneen Abrams, Graduate Research Assistant, Jeff Boehm, Graduate Research Assistant, Department of Plant Sciences, Univ. of Tennessee

Objective: Utilize germplasm resources to develop elite herbicide resistant soybean lines

Approach: A set of high yielding glyphosate herbicide resistant soybean lines were yield tested in 2013 as first year replicated field trials in West Tennessee and East Tennessee. This series of lines were derived from reselecting advanced homozygous single plants from a recent population containing exotic germplasm parentage developed by our TN program (TN01-294RR × and LG98-1445). The female parent contains the original Monsanto glyphosate herbicide resistance gene (event 40-3-2) whose patents will expire in March 2015. We developed the female of the cross by making three backcrosses with our high yielding recurrent parent line TN93-99, which is registered germplasm line GP-280 in the USDA Germplasm Collection. The male pollen donor line is registered germplasm line GP-318 in the USDA Germplasm Collection and it contains two exotic pedigree sources (PI 227333 and PI 91730-1) that collectively contribute less than 10% of the genes to U.S. soybean cultivars. The opportunity to instill new high yield genes for continued future genetic gains was a milestone objective of this project.

Results: Weather patterns in the region produced a record state wide soybean yield. In our field test of the new high yielding glyphosate resistant line selections, the test mean of 43 new line entries plus 3 commercial checks was 59.6 Bu/A, a result that shows strong genetic performance potential for seed yield. Among the top 10 yielding lines were four of our new genetic diversity lines which averaged 64.5 Bu/A or 108% of the test mean. Two of the commercial checks also performed among the top 10 yielding entries with the mean of those checks strongly yielding at 65.4 Bu/A. It is notable that our new line TN13-5538RR1 produced 66.5 Bu/A seed yield, which was greater than the mean of the best checks. That new line and others have been selected for further broader scale field testing in 2014.

Project Title: Germplasm Resources for Conventional Soybean Seed Yield Improvement

Personnel: Vince Pantalone, Professor; Chris Smallwood, Research Associate; Ben Fallen, Research Associate; Debbie Ellis, Research Associate; Rachel Fulton, Research Associate; Beth Meyer, Research Associate; Jeneen Abrams, Graduate Research Assistant, Jeff Boehm, Graduate Research Assistant, Department of Plant Sciences, Univ. of Tennessee

Objective: Develop elite conventional soybean lines through germplasm resources

Approach: A cross was made between two high yielding cultivars (5601T, CV-441 and 5002T, CV-466) that we developed and registered in the USDA Germplasm Collection. The progeny line TN05-5018 (relative maturity 4.9) was released as excellent high yielding conventional (non-GMO) cultivar 'Ellis' in 2013.

A cross between two registered cultivars in the USDA Germplasm Collection (Fowler × Anand) produced progeny line TN09-008 which was evaluated in the 2013 Southern Uniform Test (MG V) over approximately 22 environments.

Results: Our new variety Ellis was field tested in several elite yield trials in 2013 where it was the top yielding entry and the plants showed remarkable resistance to lodging despite the heavy rains and pod loads with yields exceeding 70 Bu/A. Participants in the USDA Southern Uniform Soybean Tests approved Ellis to become the new high yield performance check for the maturity group (MG) IV-Late and the MG V southern regional trials. UniSouth Genetics, Inc. of Dickson, TN will market seeds of Ellis under the brand name 'USG Ellis' beginning with seed sales to farmers in early 2015.

In the 2013 USDA Southern Uniform Preliminary Test (MG V), grown over approximately 22 southern environments, line TN09-008 was among the 3 top yielding entries of the 27 entry test that included two glyphosate resistant commercial high yield checks and three conventional high yield checks. It is notable that TN09-008 showed excellent seed yields with a mean of 61.9 Bu/A which exceeded that of every check. Moreover, TN09-008 pathogen testing results showed extraordinary SCN resistance, with the best possible scores (1, 1, 1) for resistance to SCN Race 2, SCN Race 3, and SCN Race 5 (HG types 1.2.5.7, 5.7, and 2.5.7, respectively. This line is presently being considered for possible cultivar or SCN resistant high yielding germplasm line release, with proposed deposit to the USDA Germplasm Collection.

Biofuel Crop Alternatives:
Switchgrass
Project Title: Breeding improved synthetic varieties of Switchgrass
Personnel: Fred Allen, Professor; Virginia Sykes, Grad Research Assistant; and Hem Bhandari, Assistant Professor, Dept. of Plant Sciences, Univ. of Tennessee.
Objective: Development of improved varieties of Switchgrass

Approach: Three PI's are being intercrossed with two experimental lines and two released cultivars for the purpose of developing new synthetic varieties of switchgrass. A polycross nursery was established in spring 2007. F1 half-sib families were established in the field in 2009 and have been evaluated for yield and various agronomic traits in 2010, 2011, 2012, and 2013. Two new M.S. projects were initiated in 2012 on this set of materials and were completed in 2014.

Project Title: Evaluation of Lowland Switchgrass Germplasms
Personnel: Hem Bhandari, Assistant professor, Jessica Hentchel, Research Associate, Fred Allen, Professor, Dept. of Plant Sciences, Univ. of Tennessee.
Objective: Characterize switchgrass germplasms for biomass yield and other agronomic traits

Approach: Twenty three lowland switchgrass germplasm acquired from USDA-GRIN were established in a space-planted nursery in spring 2013. Each germplasm is represented by 15 genotypes. Biomass yield, yield components, and composition will be recorded in 2014 and 2015.

Project Title: Breeding improved cultivars of lowland switchgrass
Personnel: Hem Bhandari, Assistant professor, Jessica Hentchel, Research Associate, Fred Allen, Professor, Dept. of Plant Sciences, Univ. of Tennessee.
Objective: Development of high biomass yielding cultivar of switchgrass

Approach: Several hundred plants were selected in fall of 2011 from four-year-old swards of Alamo and Kanlow populations of switchgrass that were previously established and maintained by Dr. Fred Allen. Seeds harvested from the selected plants were used for progeny testing during 2012 and 2013. Nine Alamo and 7 Kanlow parental clones of superior progeny were identified. The selected clones will be intercrossed to produce improved experimental varieties of Alamo and Kanlow population sources. One MS and one Ph.D. students are involved in the project.

Fifty biparental crosses were made between genotypes of Alamo x Kanlow populations during 2013. The bi-parental cross families will be evaluated in two Tennessee locations in 2014 and 2015. Parental clones demonstrating superior hybrid potential will be identified. The selected parental clones will be clonally multiplied for used in hybrid production.

Project Title: Deciphering Allelic Variation Associated with Feedstock Trait in Switchgrass
Personnel: Hem Bhandari, Assistant professor, Jessica Hentchel, Research Associate, Alex Aust, Research Associate, Fred Allen, Professor, Dept. of Plant Sciences, Univ. of Tennessee.
Objective: Identification and mapping of important quantitative trait loci in switchgrass

Approach: A Nested Association Mapping (NAM) population was developed at the Noble Foundation by chain-crossing 10 diverse switchgrass genotypes that were previously selected from germplasm acquired from USDA-GRIN. The mapping population was generated by crossing chain-cross families with AP13 genotype. The phenotypic experiment is planted in Knoxville during summer of 2013 (1 replication) and 2014 (two replications) for identification of important gene quantitative trait loci associated with biomass yield trait. The Noble Foundation is pursuing genotypic by sequencing. The phenotypic data and genotypic data will be analyzed and QTL will be identified.

Niger
Project Title: Evaluation of Niger (*Guizotia abyssinica* L.)Accessions for Seed Production & Agronomic Traits
Personnel: Fred Allen, Professor and Victoria Knapp, Grad Research Assistant, Dept. of Plant Sciences, Univ. of Tennessee
Objective: Evaluate seed yield and seed oil potential of niger accessions, and evaluate crosses from selected parent lines for seed yield, oil and fatty acid profiles in the seed..

Approach: Fourteen niger accessions from the USDA Germplasm collection were evaluated during the summer of 2012 for seed production potential and agronomic traits. Based on those evaluations crosses were made among 6 chosen parental lines in order to determine if the feasible of selecting improved lines as new cultivars. The parental lines, F1, F2 and reciprocal backcross materials were evaluated at two locations in TN during 2013 and three locations in 2014.

Texas

About 1400 sorghum accessions were evaluated in the Texas A&M Sorghum Improvement Program in 2014. These accessions were screened for stalk juice and pithiness.

Additional sorghum germplasm was evaluated in Plainview, TX for disease resistance and agronomic traits. Sweet sorghum lines were evaluated for tolerance to low pH soils at Lubbock. Two accessions of *Panicum hallii* were evaluated at Dallas for agronomic traits.

Virgin Islands

Sorrel or roselle, *Hibiscus sabdariffa*, plant breeding has continued toward development of day neutral, dark, open and hairless calyxes that are easily harvested. Reciprocal crosses have been made and backcrosses of F_1 hybrids. We were able to evaluate the F_2 populations and make selections of the new combined characteristics. Three undergraduate students supported through the funding presented research results at a local science symposium.

Sweetpotato weevil is the most serious pest of sweetpotato, not only in the Virgin Islands and throughout the Caribbean. It causes damage in the field and in storage. The objective was to evaluate harvest date and weevil damage in sweetpotatoes. Fifteen sweetpotato varieties were grown and established in a replicated trial at one foot in-row spacing and four feet between rows. Cuttings from virus free stock plants were spaced at one foot in row and four feet between rows. Weevil traps were distributed throughout sweetpotato plantings and monitored weekly. Harvest was conducted at 120 and 150 days. Weevils were found to increase during the initial four weeks and stabilized during the rest of the growing. Through the course of the trial, 1,640 male weevils were captured and destroyed. These numbers however indicate that sweetpotato weevils were at a high pressure throughout the growing period. Marketable production was reduced the longer the sweetpotato remains in the field after 120 days.

Pitaya varieties are being grown and evaluated for growth on calcareous soils and production potential in the US Virgin Islands. Pitaya or Dragon Fruit is a cactus, closely related to the native night blooming cerius, with a large succulent fruit. Twenty-six Pitaya varieties were established in a former grape trellis wire system. Plants were set in a replicated trial at either 2 ft or 4 ft intervals. Pitaya were established and proved able to grow to the top of a six-foot trellis wire and flower within a year. Plant growth and flowering were monitored monthly and data recorded. Ripe fruit were harvested and data collected on weight, length, width, fruit flesh color and soluble sugar content. After a year of field establishment, 63% flowered and set fruit. All flowers were naturally pollinated at night by bats and moths so no hand pollination was required. Six pitaya varieties are recommended based on first year production, fruit size and sweetness.

The US Virgin Islands has completely changed their preference in sorrel to the open calyx black varieties made available through UVI-AES- Biotechnology program. The local demand by consumers is for sorrel to be available fresh in the market for eight months of the year. The local farmers have modified their production schedule to have two growing cycles to meet the increasing demand. The virus-free sweet potato varieties that have weevil avoidance through early production, 90-100 days, are being used to plant three cropping cycles throughout the year.

Virginia

Germplasm from S9 was acquired in Virginia by researchers at both Virginia Tech and Virginia State University. A switchgrass (*Panicum virgatum*) biotechnology program has been established at Virginia Tech under the direction of Bingyu Zhao. As part of this program a field planting representing the diversity of switchgrass has been established at Kentland Farm from S9 germplasm release. Some of the publications from this program reflect transgenic approaches to switchgrass improvement as well as more traditional approaches to bridging barriers between

accessions due to differences in chromosome number. Screening of switchgrass accessions for resistance to a rust fungus has revealed new sources of resistance. A joint project between Gregory Welbaum and Bingyu Zhou in the Department of Horticulture at Virginia Tech has been focused on screening *Citrullus*, *Lageraria*, and *Preacitrullus* accessions for resistance to the watermelon pathogen that causes fruit blotch, with the eventual objective of releasing blotch resistant cultivars. Two lines among hundreds screened showed putative resistance and are under more extensive evaluation.

Two projects have been completed using S9 germplasm at Virginia State University. Harbans Bhardwaj published an extensive study of the genetic variation within *Lupinus* germplasm. Lupins are considered to be a valuable high protein livestock feed and as a green manure/cover crop. The S9 collection was found to be genetically variable, offering a rich array for breeding purposes. A second study was conducted to develop genetic and genomic tools for the oilseed crop, *Vernonia*; the low viscosity and polymerizing characteristics of vernonia oil suggest its use as a nontoxic solvent in industrial coatings and paints. Ongoing projects include the evaluation of GRIN germplasm of chickpea, garden cress, guar, lablab, moth bean, trigonella, watermelon, and tepary bean to develop these crops for production in Virginia, especially for farmers in the erstwhile tobacco region.

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