A Century of Tropical Agricultural Research

PEGGY GREB (K9366-1)

Tropical islands aren't just famous for blue skies and emerald water. You can also find a profusion of tropical and exotic fruits that can reawaken the senses.

For a century, USDA scientists at the Tropical Agriculture Research Station (TARS) in Mayagüez, Puerto Rico, have been working to bring these tasty fruits to consumers everywhere and make them available for centuries to come.

"One of our new projects is to introduce, preserve, and evaluate tropical fruits that are economically important to the United States," says Ricardo J. Goenaga, the head of TARS. "Changes in the U.S. population's diet and an increase in the country's ethnic diversity have increased demand for tropical fruits.

"Puerto Rico has 300 different soil series, representing 10 of 12 major soil groups. Rainfall ranges from 35 inches in the southern semiarid region to over 80 inches in the northeastern region. We can grow tropical crops in different agroenvironments to determine where these crops grow best," says Goenaga.

At various times, you'll find familiar and uncommon crops being studied at TARS, including dry beans, sorghum, banana, plantain, and exotic fruits such as rambutan, carambola (star fruit), mamey sapote, lychee, longan, papaya, mango, and mangosteen—also known as the "queen of fruits" for being one of the finest flavored fruits in the world.

"Puerto Rican farmers have established about 2,000 acres of mango orchards in response to increased demand for these fruits," says Goenaga. "They are mostly exported to the U.S. mainland and Europe.

"Very little information is available on growing and managing tropical exotic fruits. We're trying to find out what diseases and insects, as well as physiological and environmental variables, affect their growth and yield potential."

"We want to know which insects are problems, when they attack, and what damage they cause," says ARS entomologist Randall L. Pingel. "But this process takes time. Crops like rambutan, sapodilla, and mangosteen take 4 to 8 years to bear fruit."

Tropical Plants from Afar

One of TARS' main goals during its first 40 years was worldwide tropical plant collecting. Currently, about 2,000 species are growing at the station, representing one of the best tropical plant collections in the Western Hemisphere. Many of the crops are not native to this area, like rambutan from southeast Asia or lychee from China. Exotic plants there include cinnamon, nutmeg, rubber, vanilla, black pepper, citronella, camphor, teak, mahogany, palms, and Manila hemp. Goenaga

PEGGY GREB (K9375-1)

Entomologist Randall Pingel examines papaya fruits for symptoms of papaya ringspot virus.

PEGGY GREB (K9372-2)

Sorghum flowers from various accessions give geneticist John Erpelding clues to sources of resistance against sorghum ergot, a major fungal pathogen.

PEGGY GREB (K9373-1)

Geneticist James R. Smith examines recently developed bean lines resistant to common bacterial blight.

says the lab receives germplasm requests from many countries.

The facility is part of the U.S. National Plant Germplasm System (NPGS). It introduces, maintains, characterizes, and evaluates germplasm collections of banana, plaintain, sapodilla, mamey sapote, cacao, *Garcinia, Annona,* and bamboo. Preserving these collections for future generations is extremely important, says horticulturist Heber Irizarry, who is in charge of the germplasm program.

Irizarry's main research has been on plantain and banana.

There are 28 plantain and 83 banana accessions in the TARS collection. TARS researchers have made a noteworthy contribution toward the introduction, selection, and evaluation of superior plantain and banana clones and the proper management of these crops under different environments.

TARS researchers are collaborating with other international institutions to introduce and evaluate newly released black sigatoka-resistant plantain and banana hybrids developed by the International Institute of Tropical Agriculture in Nigeria, Africa, and for the Fundación para la Investigación Agrícola in Honduras, Central America.

Black sigatoka, caused by the fungus *Mycosphaerella fijiensis Morelet,* is the most destructive disease of plantain and banana. The fungus attacks plant leaves, preventing the fruits from filling and causing drastic yield reductions. Though the disease is not present in Puerto Rico, it is in some neighboring Caribbean countries and has been reported in South Florida.

Truly Diverse Beans and Grains

There are very few dry-bean breeders in the world, and ARS geneticist James R. Smith is one of them. Smith has a fondness for beans, which are high in dietary fiber, low in fat, and a good source of protein. He's responsible for the TARS bean project, designed to improve bean germplasm by increasing genetic diversity.

"We are collaborating with researchers at Zamorano, a Pan-American School for Agriculture in Honduras, to develop bean varieties resistant to common bacterial blight," says Smith. "We are developing bean germplasm for several different market classes, of which the United States has at least 10. Typical uses for some of these market classes include dark red kidneys for salad bars, small red beans for chili, navy beans for pork and beans, and pintos for refried beans."

A problem with growing tropically adapted beans in the temperate United States is that many tropical varieties are

PEGGY GREB (K9378-1)

In Corozal, Puerto Rico, plant physiologist Ricardo Goenaga (foreground) and agronomist Edmundo Rivera collect carambola fruits to check for brix (sweetness) in a variety trial.

PEGGY GREB (K9379-1)

Horticulturist Heber Irizarry (left) and technician Nicolas Diaz discuss the ideal stage for harvesting cacao pods.

sensitive to day length. Smith is trying to make valuable photoperiod-sensitive tropical varieties less sensitive to day length so they can be grown in the United States.

Germplasm research at TARS involves cereal grain crops, like sorghum and corn. About one-fifth of the world's sorghum is produced in the United States on only 4 percent of the country's agricultural land. Sorghum is a major food crop in Africa and Asia, but in the United States, the grain is used to feed livestock. Two-thirds of ARS' National Sorghum Germplasm Collection is from Africa, and some of the germplasm was obtained 100 years ago. The collection is stored at Griffin, Georgia, and Fort Collins, Colorado, and contains more than 40,000 seed samples from 106 countries, including most African and Asian nations. TARS geneticist John E. Erpelding is curator of the collection. His primary focus is to identify useful genetic variation that can be used to develop new and improved varieties.

"I'm determining the characteristics for each accession. There's a considerable amount of variability in sorghum," says Erpelding. "So far, we have characterized more than one-third of the collection. Certain characteristics are adapted to specific regions. For example, a compact flower head is typically found in drier regions."

Sorghum, related to corn, is a tropical crop sensitive to day length. Most sorghums in the collection will not flower in the United States because they require a shorter day length during the growing season for floral initiation. Erpelding says he's transferring genes that influence sensitivity to day length to increase the genetic diversity of sorghum that can be grown in the United States. Since sorghum can be grown during the winter in Puerto Rico under a shorter day length, it is ideal for studying sorghums having potential use in the United States.

"A collection from Mali has recently been added to our sorghum collection," says Erpelding. "This addition will aid in preventing loss of valuable genetic material and will be useful to researchers worldwide."

Also part of TARS is a research station nestled on St. Croix in the U.S. Virgin Islands. Here, quarantined plant materials from many countries—mostly sorghum, pearl millet, and maize—are brought from the National Seed Storage Laboratory at Fort Collins via the Plant Germplasm Inspection Station at Beltsville, Maryland. Materials are grown and characterized and their seed regenerated and sent to plant-introduction stations for long-term storage and distribution to breeders and other plant scientists.

PEGGY GREB (K9371-1)

Sample of variation in the TARS sorghum collection.

Since materials are quarantined, they must be grown in isolation from commercial agricultural plantings and certified to be free of potentially harmful plant pathogens. "We follow very strict protocols to safeguard against diseases," says Goenaga. An ARS and an Animal and Plant Health Inspection Service plant pathologist check plants very carefully and certify them free of diseases before they are released for domestic use.

Looking Ahead

TARS, whose main hacienda-style building was built in 1909, will celebrate its 100th anniversary this year. Over the years the station has released about 300 tropical plant lines and cultivars.

So what's in store for the next 100 years? "A new project to identify, increase, and preserve disease-free cacao clones," says Goenaga. "Our cacao collection dates back to the 1950s and contains 200 accessions. We're collaborating with other ARS labs to study how much genetic diversity is in the current collection and to identify high-yielding clones. If we find favorable lines, we can distribute them to growers worldwide."

Future research will also focus on developing tropical fruit production systems that aid growers in expanding the markets and marketability of these crops. Goenaga says developing value-added products with increased shelf life and nutritional quality is also important for these crops. He notes that molecular biology techniques will facilitate genotypic characterization of germplasm in the sorghum collection—one of NPGS' largest—and development of new dry-bean germplasm possessing multiple stress resistance for breeding programs in the United States.—By **Tara Weaver-Missick,** ARS.

This research is part of Plant, Microbial, and Insect Genetic Resources, Genomics, and Genetic Improvement, an ARS National Program (#301) described on the Wold Wide Web at http://www.nps.ars.usda.gov.

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