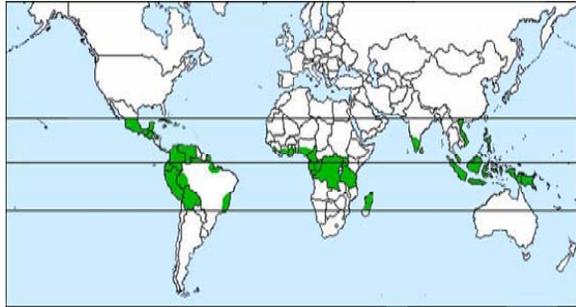


*Theobroma* (“food of the gods”) originated in the Amazon rainforests of South America, and the tree grows only within 20 degrees of the equator.



Cacao is a high-value crop and important to the world and the US economies. Markets for US commodities such as milk, sugar, peanuts, almonds, corn, raisins, and mint are linked to the availability and price of cacao beans. For every dollar of cacao imported, between one and two dollars of U.S. agricultural products are used to make chocolate.

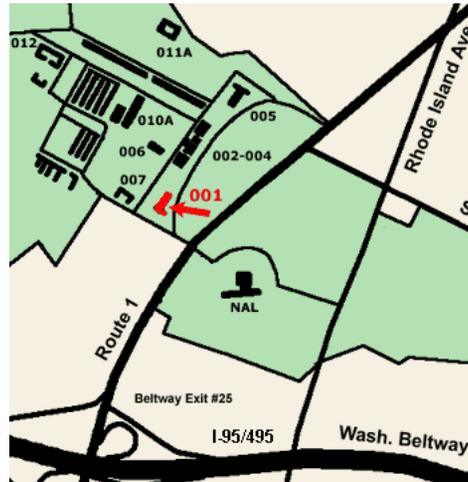
Thousands of U.S. jobs depend on the more than \$17 billion chocolate industry in the U.S., in fields such as manufacture, packaging, sales, and shipping of products for home and export.

The availability, price, quality, and stability of supply of the cacao crop are also important to global security. Each year, nearly 4 million tons of cacao beans are grown in developing countries by 6 to 7 million small-scale farmers. In many areas, farmers have replaced the illegal drug crops they grew previously, with cacao trees – a legal, high cash value crop that grows in the same conditions and has an enthusiastic market, especially in the U.S., which is the world’s largest consumer of chocolate.

The SPCL collaborates with a wide network of national and international colleagues from universities, government and non-government research centers, industry, and directly with cacao farmers, to improve and maintain crop yields, while safeguarding the environment.

## Sustainable Perennial Crops Lab Agricultural Research Service U.S. Department of Agriculture

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Beltsville, Maryland  
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Upon arrival, all visitors must first report to the Security Division in Building 003

Visit our Webpage at:

[www.ars.usda.gov/chocolate](http://www.ars.usda.gov/chocolate)

## Sustainable Perennial Crops Laboratory

### Research Mission

The mission of the SPCL is to improve production of tropical woody crops using sustainable systems.



Our goal is to provide farmers with methods to increase crop production, improve genetic diversity, and reduce the impact of crop management on the environment.

It is important for U.S. agriculture to provide both manufacturers and consumers with safe and stable supplies for goods that we produce. Availability of these raw materials results in products for U.S. consumption and export, and in jobs for Americans.

This brochure describes one focus of our research program. *Theobroma cacao* is the tree crop that provides cacao for manufacture of chocolate and other products. Our research includes biological control strategies for fungal diseases of cacao that are among the world’s worst cacao problems.



## Using Molecular Tools to Improve Biological Control of Cacao Diseases

Objective: Develop and optimize strategies that result in improved plant productivity and effective control of cacao diseases caused by *Moniliophthora* species of fungi.



*M. perniciosa*:  
Witches' Broom

*M. roreri*:  
Frosty Pod

- Determine the molecular mechanisms that result in disease development by the fungi *Moniliophthora perniciosa* and *M. roreri*.
- Identify potential targets in the disease process that could be blocked.
- Identify and characterize isolates of the biocontrol fungus *Trichoderma* that inhibit undesirable, disease-causing fungi.
- Study interactions, between *Trichoderma*, *Moniliophthora*, and cacao in various environments.
- Develop and test strategies to overcome treatment problems in the field.



Witches' Broom

## Sustainable Management Systems for Tropical Tree Crops

Objective: Develop environmentally friendly systems to increase efficiency of cacao cultivation, and improve yield and bean quality.

- Identify particular cacao varieties with improved growth in stressful environments such as drought, acidic soil, and shade.
- Analyze soil nutrients to determine how cacao yield can be optimized.
- Test effects of various cover crops on cacao yield.
- Develop and field-test integrated management systems for improved growth, production, and quality of cacao under differing environmental conditions.



Cover crop under cacao trees



Chocolate

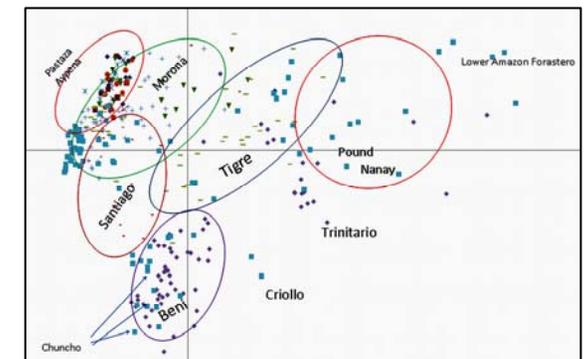
Pod

Beans

## Molecular Analysis of Cacao Germplasm and Diversity

Objective: Develop tactics to manage and advance diversity of cacao germplasm, which is preserved as trees. These living genebanks are more difficult to manage than seed collections, but are necessary because cacao seeds cannot germinate after storage.

- Fingerprint the DNA of cacao trees in genebanks, to identify mislabeled and duplicate trees.
- Add molecular data and integrate with physical descriptions of cacao varieties and pedigree data in international cacao databases.
- Analyze geographical distribution of cacao varieties, and collect and identify new germplasm from previously unexplored tropical locations. Supplement collections with trees carrying newly discovered traits, to increase diversity of germplasm.
- Develop schemes to guard and enhance genetic diversity in farm and nursery tree collections.
- Characterize and evaluate traits of cacao with significant economic value, and identify germplasm sources for breeders.



New, genetically diverse germplasm has been found in river valleys of the Amazon.