Safeguarding the Seeds of our Food Security: the U. S. National Plant Germplasm System

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Outline for presentation

• Challenges to the Nation’s crops
• Genetic solutions--The U. S. National Plant Germplasm System: safeguarding our food security
• Examples of plant germplasm’s contribution to food security
Directly or indirectly, crops provide nearly all of humanity’s food.
Ug 99: a virulent form of wheat stem rust

- A fungal disease that originated in Uganda, and has spread throughout northeast Africa into the Near East.
- Highly damaging to wheat, causing major crop losses.
- Current U. S. wheat varieties are susceptible.
Laurel wilt, a fungal disease spread by beetles, and lethal to avocado, sassafras, and other laurels

Introduction & Spread

2002 – first observed in U.S. near Savannah, Georgia

2010 – has spread as far south as Miami-Dade Co. and as far west as MS.

No known resistance in avocado; uniformly susceptible.
Catastrophic loss of Michigan’s genetically uniform cherry crop

- Dominated by one variety, Montmorency. The genetic content and annual growth cycle of all the trees are nearly identical.
- 2002 and again in 2012: 90% of Michigan’s crop destroyed by a late freeze, with a loss of tens of millions of $. (A. Iezzoni, MSU)
Continued progress in plant genetics and breeding are keys to food security

Breeders and researchers turn to “genebanks” for “plant germplasm” (a/k/a “plant genetic resources”) to develop superior crops that are more diverse genetically, resistant or tolerant to these threats, more productive, with new features important to producers and consumers.
What is plant germplasm?
Seeds, fruits, cuttings, pollen, and more--the raw material for crop breeding that underpins food security, and plant research.
The USDA/ARS National Plant Germplasm System (NPGS) conserves plant germplasm and enables its use in research and breeding.

- One of the largest national genebank systems.
- More than 549,000 samples of more than 14,500 plant species.
- Large collections of the major staple crops important to U. S. and world agriculture.
- Large holdings of crops without major collections at international agricultural research centers, e.g., cotton, soybean, various horticultural and “specialty” crops.
- Germplasm Resources Information Network (GRIN): an international standard.
NPGS Components

- National Genetic Resources Laboratory, Beltsville: GRIN database; exploration.
- 18 genebanks with “active collections”.
- Crop Germplasm Committees; university, NGO, International Agricultural Research Centers, and industry cooperators.

The NPGS genebanks manage and conduct research with germplasm of:
- Grains and oilseeds
- Vegetables and fruits
- Fiber, forage, and feed
- Sugar, herbs, spices, ornamentals, medicinals
USDA National Plant Germplasm System (NPGS)
Examples of NPGS genebanks
Genetic resource management

• Acquisition through exploration and exchange.
• Genebank maintenance in orchards, slow-growth conditions, and low-temperature storage.
• Regeneration (increases) via controlled pollination, clonal propagation, etc.
Wild apple seedling orchards at NPGS genebank, Geneva, NY

Malus spp. - China


M. orientalis – Russia & Turkey

M. sieversii – half sibs of clonal elites being maintained
Genetic resource management

- Characterization (genetic marker analyses, taxonomic identification, “fingerprinting”).
- Evaluation for agronomic or horticultural traits across multiple sites and years.
- Data management in Germplasm Resources Information Network (GRIN).
Evaluating young wild apple seedlings for resistance to apple scab

A-type resistance ‘chlorotic’

B-type resistance ‘stellate necrotic’
Welcome!

In 1990, the U.S. Congress authorized establishment of a National Genetic Resources Program (NGRP). It is the NGRP's responsibility to acquire, characterize, preserve, document, and distribute to scientists, germplasm of all lifeforms important for food and agricultural production.

The Germplasm Resources Information Network (GRIN) web server provides germplasm information about plants, animals, microbes and invertebrates. This program is within the U.S. Department of Agriculture's Agricultural Research Service.

The National Genetic Resources Advisory Council (NGRAC) advises and makes recommendations to the Secretary and Director of the NGRP. The NGRAC responds to the important issues of the nation in respect to conserving and utilizing genetic resources for food and agriculture.
Genetic Resource Management

- **Distribution**: NPGS annually distributes an average of about 200,000 samples to researchers worldwide.
- An average of about 75% are distributed domestically, and 25% internationally.
- **Samples are distributed free-of-charge and without restriction**
DEMAND FOR NPGS GERMPLASM AND INFORMATION VS. NPGS BUDGET

NPGS Web Page Access

Germplasm Distribution

NPGS Annual Budget
Rice Blast disease is one of the most destructive diseases of rice worldwide. Blast kills plants at the young seedling stage and can result in complete loss of grain. Tetep (PI 431324), a variety introduced from Vietnam in 1978, is the source of a resistance gene that provides protection from this devastating disease. Through breeding, this resistance gene has been introduced into many USA varieties, including Spring, Kaybonnet, Katy, CL111, Madison, Catahoula, Templeton, and Cybonnet.
### Impact of one seed sample of peanut

- **Peanuts**
- **Tomato spotted wilt virus** – problem since late 1980s
- **PI 203396** collected in Brazil market in 1952, maintained in collection with minimal use
- Has excellent resistance to TSWV
- Incorporated into >20 peanut cultivars

#### Economic Impact of PI 203396
- $2 billion (1996-2005)
- $200 million annually

#### Five peanut cultivars – 95% of SE acreage in 2011
- **All have TSWV resistance from PI 203396**
  - Georgia Greener
    - 25% PI 203396
  - Georgia-06G
    - 25% PI 203396
  - Georgia-07W
    - 25% PI 203396
  - Florida-07
    - 12.5% PI 203396
  - Tifguard
    - 12.5% PI 203396
WHEAT STEM RUST – Race Ug99 – A Global Threat to Food Security