

Expanding Learning Resources for Plant Genetic Resource Conservation and Use

Pat Byrne, Gayle Volk, and Peter Bretting



Agricultural
Research
Service



Translating Visionary Science to Practice

Presentation outline

- Need for additional learning resources
- History of this initiative
- Progress to date
- Future plans



Background

- Future progress in plant breeding depends on the availability of diverse genetic resources and associated information.
- Genebanks around the world serve essential functions by acquiring, maintaining, distributing, characterizing, and documenting a broad array of genetic resources.
- Among the challenges faced by genebanks in carrying out these functions is adequate training in the multiple skills required by curators and users of the genetic resources.



Need for more learning resources: Retirements in National Plant Germplasm System



Gary Pederson
RL, Griffin, GA



LJ Grauke
Pecan, Somerville, TX



MaryLou Polek
Citrus, Riverside, CA



Joseph Postman
Pear, Corvallis, OR



Randy Nelson
Soybean,
Urbana IL



Candy Gardner
Maize,
Ames, IA

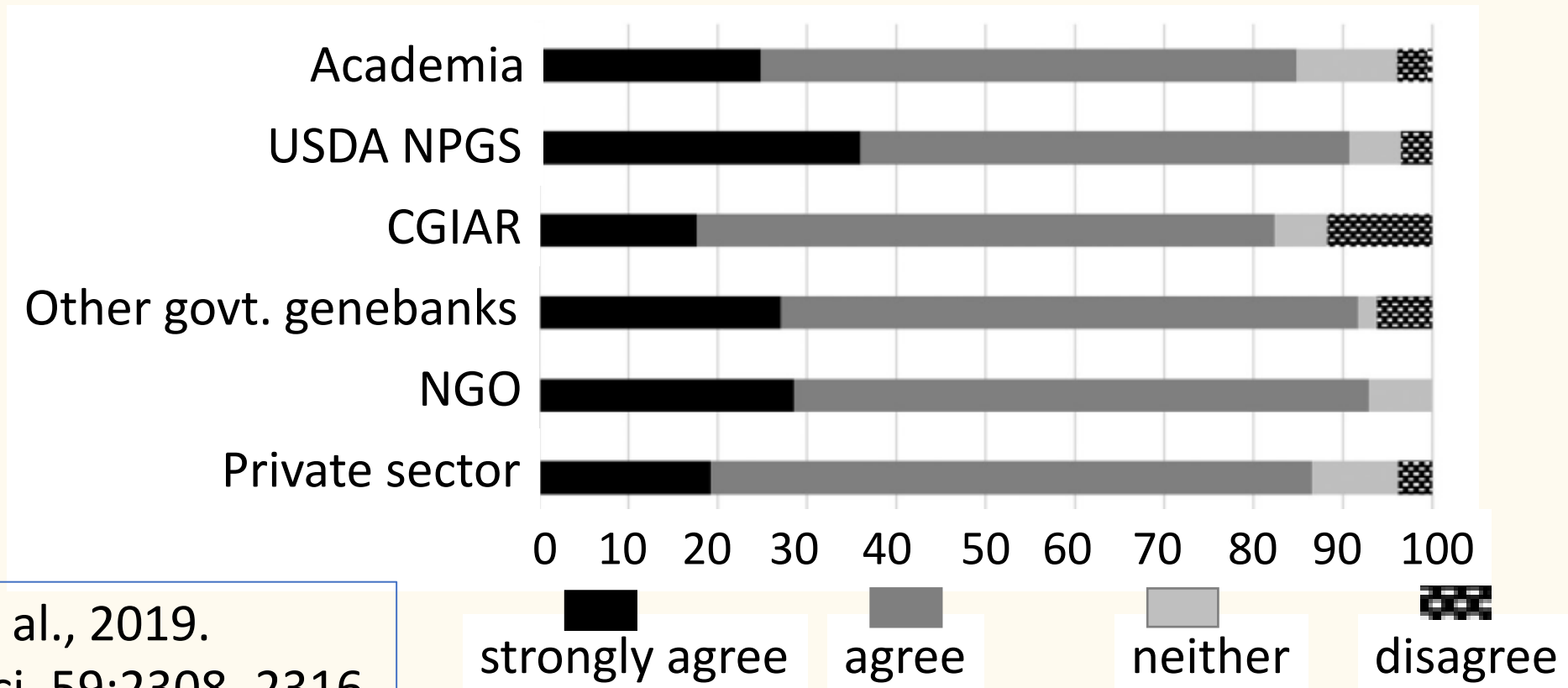


Jinguo Hu
RL, Pullman, WA



Need for more learning resources: Online survey question

There is a shortage of high quality learning materials on plant genetic resources.



Volk et al., 2019.
Crop Sci. 59:2308–2316



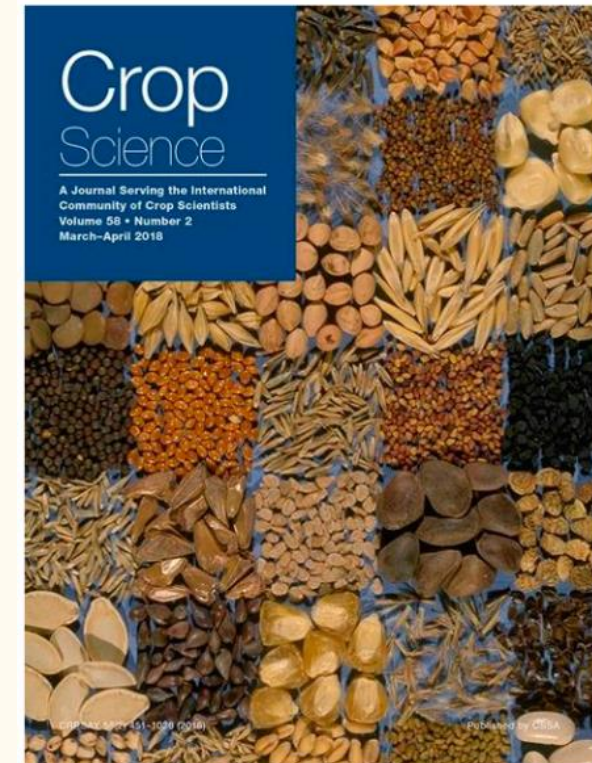
In 2015, Plant Breeding Coordinating Committee recommended analysis of the health and sustainability of the NPGS

Sustaining the Future of Plant Breeding: The Critical Role of the USDA-ARS National Plant Germplasm System

P.F. Byrne,* G.M. Volk,* C. Gardner,
M.A. Gore, P.W. Simon, and S. Smith

To make the NPGS even more relevant
to plant breeding

- Optimize collections
- Improve phenotypic and genotypic information
- Enhance collaborative activities
 - ❖ *Training and Outreach Needs*



Byrne, Volk et al., 2018.
Crop Sci. 58:451–468



Planning Conference Co-Hosted by National Laboratory for Genetic Resources Preservation (NLGRP) and Colorado State University



April 24-26, 2018,
Fort Collins, Colorado

Photo: L. Guarino

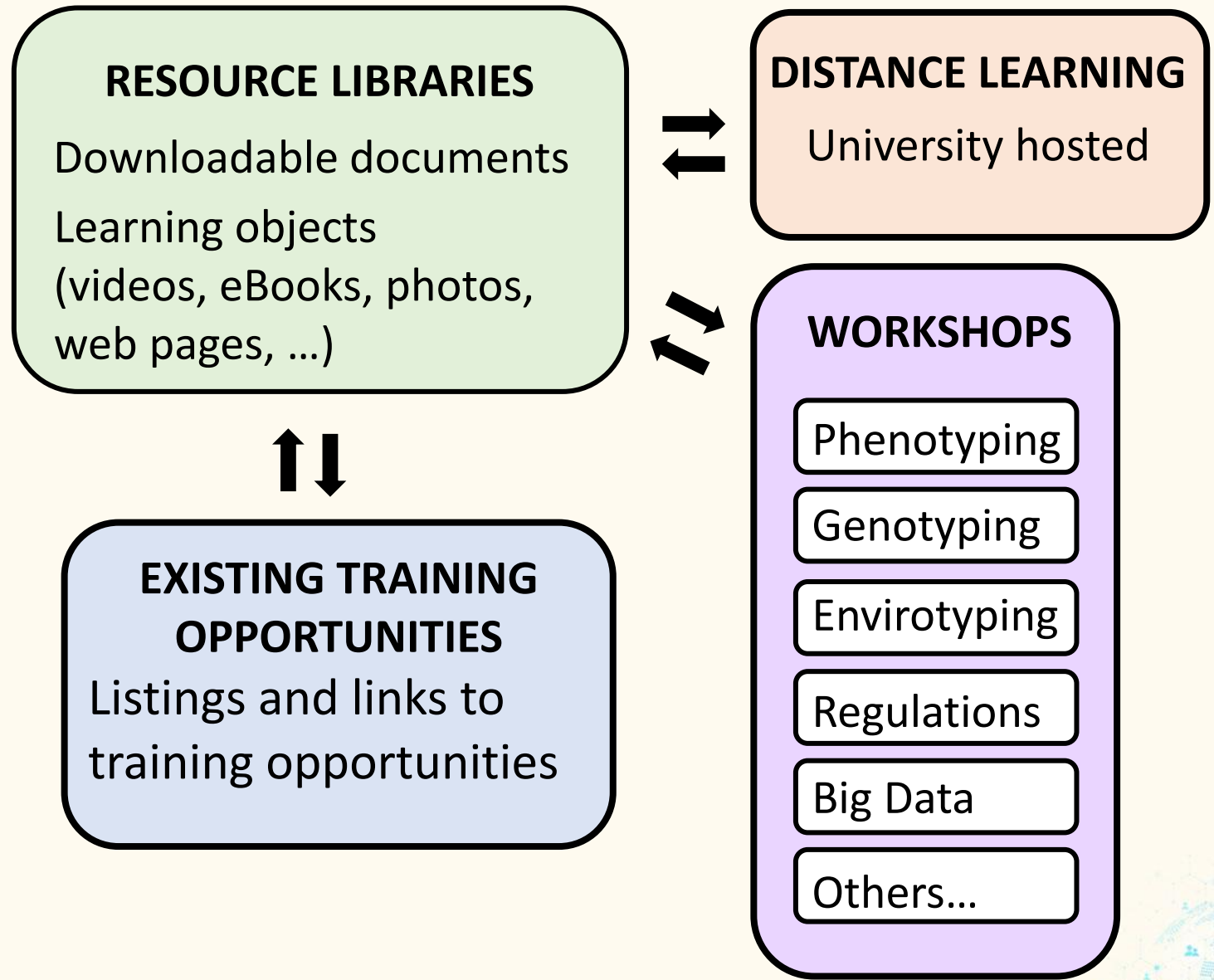
- Funded by USDA-NIFA.
- 33 attendees represented USDA-ARS & NIFA, land-grant universities, seed industry, national genebanks of Canada and Mexico, botanic gardens, and The Crop Trust.



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Workshop attendees proposed a versatile set of interconnected training resources.

Volk et al., 2019.
Crop Sci. 59:853-857



USDA-NIFA Higher Education Challenge (HEC) Grant Project (2020-2023):

Enhancing Educational Outcomes for Plant Genetic Resources Conservation and Use



Pat Byrne, Maria Munoz-Amatriain, Jill Zarestky, and a Master's level Graduate Research Assistant



Walter Suza and a Master's level Graduate Research Assistant



Gayle Volk (Fort Collins), Candy Gardner (Ames), Gary Kinard (Beltsville)

Consultant

Deana Namuth-Covert (Lincoln)



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HEC project objectives include



- 1) Develop an organized series of learning resources (videos, ebook chapters, images, etc.) covering priority PGR topics.
- 2) Establish an online repository at USDA-GRIN to host, organize, and track usage of the developed content.
- 3) Develop and offer three 1-credit graduate-level online course modules at CSU on PGR conservation and their use in plant breeding.
- 4) Disseminate the developed materials broadly to communities of interest, including 1890 land-grant universities, Tribal Colleges, and Plant Breeding eLearning in Africa participants.

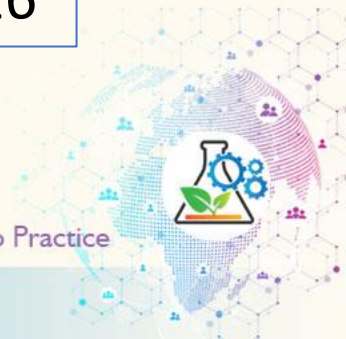


Progress to date

An online survey to assess training needs was conducted in March 2019.

- 425 usable responses were received
- Among the high priority topics identified were
 - Crop wild relatives
 - Gap analysis
 - Germplasm preservation
 - Phenotyping
 - Genotyping
 - Prebreeding
 - Intellectual property issues

Volk et al., 2019.
Crop Sci. 59:2308–2316



Two infographics were funded by the National Association of Plant Breeders

1) Conserving plant genetic resources

<http://www.genebanktraining.colostate.edu/infographics.html>

PLANT GENETIC RESOURCES
GENEBANKS AND CONSERVATION

Plant genetic resources—the wide range of crop varieties and their wild relatives—are important to safeguard food security, both now and in the future.

Plant genebanks have diverse collections that are agriculturally and economically important. These collections may be conserved as seeds in cold storage or as plants in the field, greenhouse, or in tissue culture.

High quality genebank collections are critical for the future of global agriculture. Research develops new technologies and helps identify new methods for efficient, cost-effective conservation.

Key disciplines include:

- crop science
- horticulture
- pathology
- plant biology and physiology
- taxonomy
- plant genetics and breeding

Acquisition
New plant materials come from plant explorations and exchanges within the country and internationally. International imports are tested to make sure they are free of pathogens.

Maintenance
Plant genebanks are responsible for keeping collections alive and healthy. Seeds in cold storage must be periodically germinated to make sure they are still alive. Sometimes collections are kept as field or greenhouse plants.

Evaluation & Characterization
Trait data are recorded for the plant collections. In addition, genetic methods assess collection diversity and determine if varieties are true-to-type. These data can also be used to identify collection gaps. Collection documentation is critical for genebank user communities to identify materials of interest.

Documentation
Data for the source, traits, and maintenance of genebank collection materials are kept in databases, such as GRIN-Global. GRIN-Global is a publicly available website that provides up-to-date information for genebank collection of the U.S. National Plant Germplasm System.

Regeneration
Plants may be grown in the field to produce more seeds using techniques that do not change each sample's genetic composition.

Secure Backup
Duplicate collections are maintained at a secure secondary location. This ensures that collections will not be lost as a result of disease, pathogens, or environmental disasters. These backup collections are often kept as seeds in cold storage. Dormant tree buds, shoot tips, pollen, and seeds may be preserved in liquid nitrogen.

Distribution
Plant collections are provided to scientists who need access to novel genetic variation for research and breeding.

USDA Agricultural Research Service | Colorado State University | NAB | For more information, contact: Gayle.Vol@usda.gov or Patrick.Bjorn@colostate.edu | U.S. National Plant Germplasm System: <https://www.ars-grin.gov/Pages/Collections> | Design: Credit: Nucera Design Studio

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NAPB-funded infographics

2) Utilizing plant genetic resources

<http://www.genebanktraining.colostate.edu/infographics.html>

PLANT GENETIC RESOURCES
THE KEY TO GLOBAL FOOD SECURITY

Plant breeders utilize the genetic diversity of **plant genetic resources (PGR)**—the wide range of crop species and their wild relatives—to develop new crop varieties.

Plant breeders use PGR by evaluating plants for traits of interest, selecting the best, and crossing them to adapted varieties.

PGR are crucial for adapting crops to changing climates, combating new strains of diseases and insects, and developing healthier foods:

- Evolving threats from insects and diseases
- Degrading land and water availability
- Increased demand from a growing human population
- Changing temperatures and rainfall patterns

PGR include current and traditional varieties and related wild plants.

Crop wild relatives are the ancestors of crops and related species found in their native habitat.

Landraces are traditional varieties selected by farmers for adaptation to local conditions.

Crop varieties have been developed by plant breeders and farmers.

Modern yellow dent corn hybrid

Maize land race (from Mexico)

Teosinte Wild crop relative (from Mexico)

Gene banks acquire, maintain, document, and distribute PGR.

After thorough PGR evaluation and often subsequent breeding with current crop varieties, a new improved variety with novel traits is developed.

Plant breeders use PGR to develop improved varieties that are:

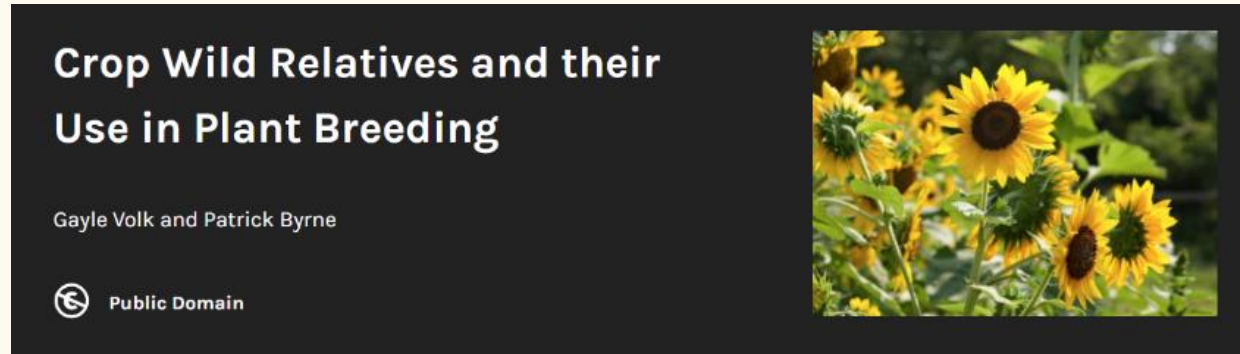
- Insect Resistant:** Wheat varieties resistant to the Russian wheat aphid (a species resistant to genes from a variety developed in Turkmenistan).
- Higher Yielding:** Sunflowers with higher seed yield have been developed from several U.S. wild sunflower species. Traits that enabled production of higher yielding hybrid cultivars were obtained from wild sunflowers.
- Disease Resistant:** Resistance to a devastating fungal disease (late blight of tomato) was found in a wild tomato relative collected in Peru. This trait has been used in several commercial varieties.
- More Nutritious:** Crop wild relative *Milaria nivensii* is used in breeding red-fleshed apples. This supplies other improved nutrition and provides a pink blush to hard ciders.

USDA Agricultural Research Service | Colorado State University | NAPB

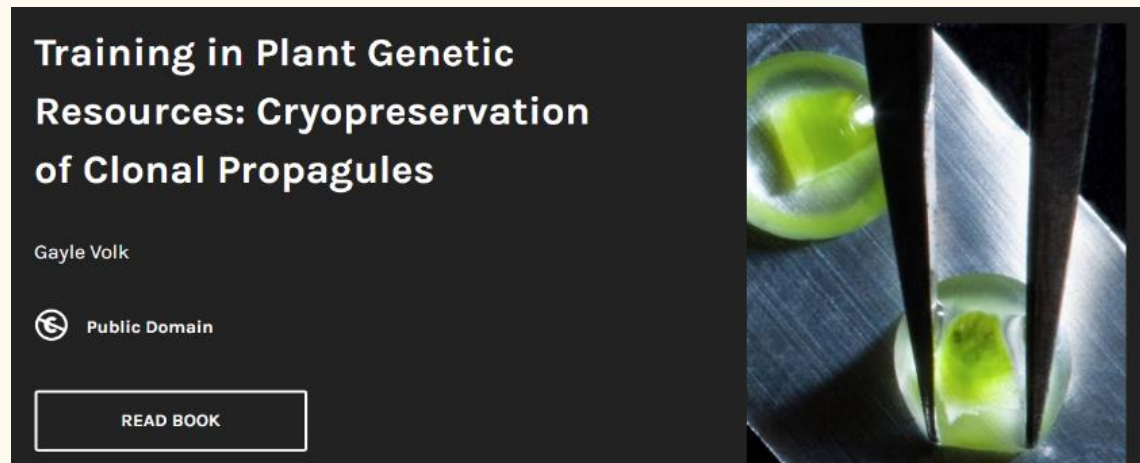
For more information, contact Patrick Byrne at colostate.edu or GeneBanks@aphis.usda.gov.
Byrne, Volk, et al. 2018. Sustaining the Archive of plant breeding: The critical role of the USDA-ARS National Plant Germplasm System. *Crop Science* 58:452–458.
Design Credit: Fluxus Design Studio

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Two eBooks on crop wild relatives and cryopreservation were published



<https://colostate.pressbooks.pub/cropwildrelatives/>



<https://colostate.pressbooks.pub/clonalcryopreservation/>



Coming in 2021-2022

- Virtual tours of the National Laboratory for Genetic Resources Preservation in Fort Collins and USDA's clonal repository in Davis, CA.
- Additional eBook chapters
- Online open-access repository of videos, eBooks, and images
- Graduate-level online courses at Colorado State University and through the Plant Breeding eLearning for Africa Program



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In conclusion,

- An array of learning materials is being developed to meet multiple needs and reach various audiences.
- We need your help to describe and illustrate success stories, evaluation techniques, and novel methods.
- We hope these educational resources will be widely used in university courses and informal educational settings, thereby enhancing understanding of the importance of crop genetic diversity in global food security.





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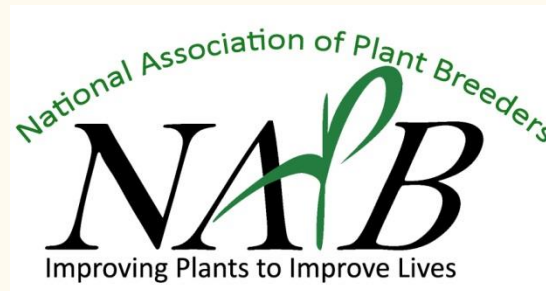
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Plant Breeding
Coordinating
Committee



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