Crop Science
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Plant Genetic Resources: An Essential Foundation for U.S. and Global Provisioning, Economy, Sustainability and Security

The U.S. economy relies on continued gains in agricultural productivity to minimize the costs of food (among the lowest in the world at 11% of disposable income), increasing household discretionary spending and contributing to national and global food security. Agriculture contributes directly to the U.S. economy with $374B cash receipts, delivering a $43B trade surplus in 2012, as well as biomaterials and energy. Underpinning U.S. agriculture and its success are crops and traits that have been developed by researchers, often introduced from other regions. Starting with the founding of USDA and the Land Grant University System 150 years ago, investments in improved plants have brought enormous benefits to humanity and generated a global agribusiness community worth trillions of dollars.

The process of plant improvement in agriculture, known as plant breeding, is ongoing as pests and diseases evolve and new market and environmental challenges continuously arise. Agriculture now faces a host of intensifying challenges with global population increases and increasing weather extremes. New traits that will boost crop performance and value will depend on continued access to storehouses of plant genetic resources (seeds and other materials, collectively termed “germplasm”), maintained by the USDA National Plant Germplasm System (NPGS), universities, research organizations and companies around the world. These collections, in aggregate, are fundamentally important to our ability to maintain a vibrant U.S. bio-economy, national security, and an adequate global food supply. Their future will depend on ongoing access to funding to support the collections and continued investments in their curation and characterization. A key opportunity in the near term will be linking recent advances in the life sciences and information technology to leverage further value and efficiencies from these critical assets.

The status of crop genetic collections

For nearly 200 years, our nation has invested in acquiring, characterizing, and maintaining plant collections to support the continued improvement of economically important plants. Because these plants are maintained alive, collections require periodic “regeneration” (growing plants and collecting new seeds). The backbone of our nation's genetic resources for crops, the USDA NPGS, regenerates thousands of lines each year, distributing 300,000 samples in 2012 to the research community and general public. Additional plant genetic collections exist in more than 150 countries, many containing types and species that are not well represented in the U.S. The world's collections, however, are far from complete. Habitat destruction and environmental stresses in many regions threaten native plants that have as yet untapped potential. Ongoing and agile acquisition programs are critical to prevent irrevocable loss of key resources.

The usefulness and value of germplasm collections are greatly advanced when basic characterization and evaluation data are readily available along with the requested living material, allowing users to target sampling of collections to expedite research and breeding efforts. Current support for curation, characterization and evaluation has not kept pace with demand. Moreover, new challenges arise from the generation of large-scale genetic resources from applied genomics research.

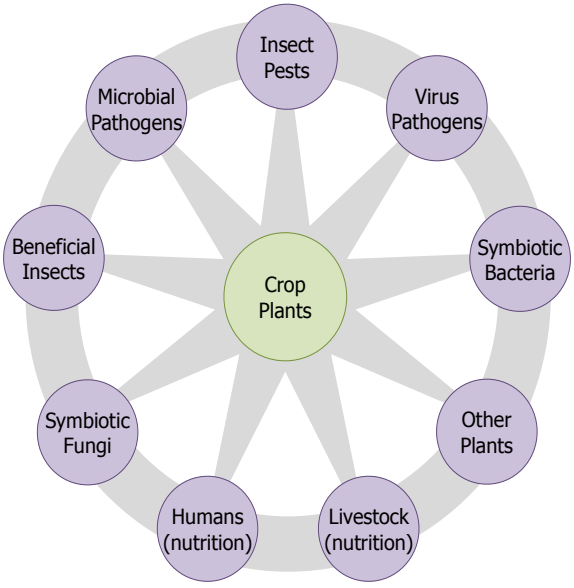
Genomic and information technologies for exploiting crop genetic diversity

New genomic, metabolomics, phenomic, and informatic technologies have the potential to radically enhance the characterization, management, curation, and use of plant genetic diversity. Additional benefits will accrue as research investments link specific genes to crop traits and performance. To date, however, germplasm and genomics databases, supported by USDA, NSF, and the U.S. Department of Energy remain largely unlinked. Federal agencies are moving to align some of these database investments for plant genomics (e.g., NSF's flagship plant database, iPlant and DOE's systems biology database, Kbase), allowing the integration and inter-operability of data and information from a wide array

of sources including private sector depositions. The NPGS collections, databases, and other key holdings of relevance to U.S. agriculture must be adequately maintained and curated, then integrated into these powerful and heavily invested capabilities for our research community and our nation's agricultural future.

Diversifying our genetic portfolio for a more secure agricultural future

To ensure continued gains in crop performance and enhanced productivity of our agricultural production systems, we will draw heavily on both current and alternative crops (e.g., "cover crops" that enhance soil health) and a wide range of "helper" organisms such as beneficial insects (e.g., honey bees and other pollinators) and microorganisms. To meet tomorrow's challenges, plant breeders will focus on an increasingly diverse array of species and will master complex inter-species interactions to more effectively manage the genetic networks that underlie productivity and resilience of agricultural systems (see diagram). Fundamental to this progress will be the collections of genetic resources from which new traits and improved performance will be derived. Without adequate funding to maintain these collections, and to link research findings to their applications in farmers' fields, we will not realize this potential in a world where food prices are at near record highs, global grain stocks are at near record lows, and increasing global population and affluence create intensified demands on increasingly degraded resources. In short, the strategic importance of U.S. agriculture has never been more obvious or more threatened.



Crop plants interact with other organisms in agricultural systems. The genetics of each organism helps to determine the outcome of their interactions, and the performance of the system overall.

Recommendations

Because plant genetic resources are critical to our Nation's future, we strongly support efforts to improve access, conservation, curation, and characterization of plant genetic resources and other genetic collections upon which our agriculture and economy depend. Our specific recommendations are as follows:

1. Ensure stable and adequate funding for curation, acquisition, maintenance, characterization, genotyping, high-throughput phenotyping, and evaluation of the USDA NPGS and other genetic collections relevant to agriculture. Specifically, stable funding is essential to maintain and characterize collections, to link NPGS holdings to other major plant genomics and systems biology databases, and to acquire new materials to allow curators to reflect the priorities of their respective research and breeding communities.
2. Develop policies that ensure U.S. researchers will have ongoing access to global plant genetic resources. Ratify the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA), to allow U.S. researchers full and timely access to global plant genetic resources.
3. Request that the National Research Council convene an expert independent panel, including distinguished agricultural and non-agricultural scientists, to provide an urgently needed comprehensive review of our genetic resources infrastructure to assess preparedness to adapt to intensifying demands on agriculture and rapidly changing conditions. This panel should review U.S. collections, federal and otherwise, and recommend specific actions to secure future long-term integrity, viability, and access to these critical genetic resources that are necessary for a vibrant agriculture for the U.S. and the world.
4. Support the OSTP National Science and Technology Subcommittee Working Groups' efforts to integrate databases for genetic resources and agricultural research. Improved integration and inter-operability of data resources, including genetic resources and other scientific collections, will be fundamentally important to meet 21st century agricultural challenges. This will also increase the benefit for genetic resources and related research of major investments in systems biology, and genetic sequence knowledge management systems across USDA, NSF, DOE and the NIH National Center for Biotechnology Information.

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