Seed Collection and Plant Genetic Diversity, 1900-1979 [1]

By: Baranski, Marci Keywords: plant genetic resources [2] plant collection [3] seed bank [4] seed collection [5]

Farmers have long relied on genetic diversity to breed new crops, but in the early 1900s scientists began to study the importance of plant genetic diversity for agriculture. Scientists realized that seed crops could be systematically bred with their wild relatives to incorporate specific genetic traits or to produce hybrids for more productive crop yields. The spread of hybrids led to less genetically diversity than normal plant populations, however, and by 1967, plant scientists led an international movement for conservation of plant genetic resources through the United Nations's Food and Agricultural Organization, and later through the Consultative Group for International Agricultural Research, both of which are headquartered in Europe. To conserve plant genetic resources, researchers must collect and store plant germplasm—the genetic material required to propagate a plant—usually in the form of a seed.

In the nineteenth century, farmers, scientists, explorers, botanists, and agriculturalists collected exotic plants and tested the seeds in new environments. Agricultural experimenters and collectors stored germplasm in fields, greenhouses, and botanical gardens. The US government became involved in 1827 when President John Adams instructed the foreign consuls to collect seeds and rare plants and send them to Washington, D.C. Foreign consuls continued to collect seeds through the formation of the US Department of Agriculture (USDA), headquartered in Washington, D.C., in 1862. The USDA distributed foreign seeds to farmers and agricultural experiment stations for testing, and it created the Office of Foreign Seed and Plant Introduction, located in Beltsville, Maryland, in 1898.

The rise of genetic theories and the professionalization of plant breeding in the early twentieth century contributed to early theories of plant genetic diversity. Scientists in Europe such as Rowland Harry Biffen, Hugo de Vries [6], and William Bateson [7] along with Liberty Hyde Bailey in the US popularized Charles Darwin [8]'s concept of natural selection [9] and Gregor Mendel's genetic laws and their application to plant breeding. Based on de Vries's mutation theory, which indicated to scientists that they might be able to create new species from old ones if they learned how to mutate them, scientists recognized an importance for genetic variation to plant breeding.

Governments in the US, Europe, the Soviet Union, Australia, and New Zealand supported early efforts at plant germplasm collection. In the early 1900s the US commissioned Frank Nicholas Meyer, who trained under Hugo de Vries [6] and for whom the Meyer lemon, *Citrus meyeri*, [10] is named, to collect plant germplasm from locations in Asia, Russia, and Europe. In his travels, he met Nikolai Ivanovich Vavilov, who worked in Russia during the first half of the twentieth century and helped found theories of plant diversity, origin, and evolution [11]. Vavilov studied plant genetics in England with Rowland Biffen and William Bateson [7] at the University of Cambridge between 1913 and 1914. In the 1920s and 1930s, Vavilov publicized the loss of plant genetic diversity due to the dominance of a small number of genetically similar crops, a fact that help ground a movement for the conservation of plant genetic resources.

In the 1920s Vavilov proposed the theory of Centres of Origin of Cultivated Plants, which were eight areas of the world classified as the origins of food crops. These areas were thought to contain the most diverse wild relatives of the crops due to evolution [11] and genetic variation. Despite repression of Vavilov's theories by Trofim Lysenko and Joseph Stalin in the Soviet Union, scientists worldwide embraced his theories. Vavilov's work inspired botanists, plant breeders, and explorers in the second half of the twentieth century to lead the movement for conservation of plant genetic resources, including Jack Rodney Harlan, Erna Bennett, John Gregory Hawkes, and Otto Herzberg Frankel. The theory of Centers of Origin increased the importance of crop wild relatives for plant germplasm collection and plant breeding. Many scientists later viewed Vavilov's Centers of Origin theory as a theory about the centers of diversity, because there is not always a clear genetic origin of plant varieties.

In 1943 the Rockefeller Foundation [12], headquartered in New York, New York, funded the Mexican Agricultural Project (MAP), to improve basic crops through the collection of plant germplasm in Mexico. The MAP began an era of systematic collection, evaluation, and storage of plant germplasm, in this case, maize, wheat, and potato germplasm. The MAP preceded the formation of the first long-term seed storage facility, the US National Seed Storage Laboratory in Fort Collins, Colorado in 1958. Prior to the National Seed Storage Laboratory, most germplasm collection facilities only provided short-term storage. After World War II, many countries, including India, Brazil, and Japan had established seed banks for long-term storage of plant germplasm.

The Food and Agricultural Organization (FAO), an international organization [13] headquartered in Rome, Italy, became concerned about the loss of plant genetic diversity in wild as well as in domesticated relatives of food crops in the 1960s. The FAO had stored information about plant exploration since 1948 by cataloging plant varieties, and it had mediated between participating countries. The FAO also oversaw plant germplasm collections in countries around the world. In 1967 the FAO created a department of Crop Ecology and Genetic Resources, led by Erna Bennett and R. J. Pichel.

In 1967 the FAO and the International Biological Programme in England, organized the 1967 Technical Conference on the Exploration, Utilization and Conservation of Plant Genetic Resources in Rome, Italy. The conference popularized the term genetic resources and established a set of standards and plans for storage of plant genetic material outside of natural habitats and in seed banks. Two scientists involved in the conference, Bennett and Otto H. Frankel, argued about this strategy. Bennett advocated for conservation in the field through farmers' participation, while Frankel advocated the seed banking approach. Like the FAO, Frankel favored the seed banking approach to conservation because it allowed plant breeders to selectively draw from stored collections of plant genetic material.

Participants at the 1967 FAO conference also coined the term genetic erosion to describe the loss of plant genetic diversity due to agricultural expansion. Genetic erosion became a pressing international concern after a 1970 outbreak of corn blight in the US and the spread of coffee rust in Brazil. Echoing Vavilov, scientists highlighted the drawbacks of genetically homogenous crop populations. In 1972 the US National Research Council [14] in Washington, D.C. authored the report, *Genetic Vulnerability of Major Crops*, stating a similar argument.

The FAO advocated long-term germplasm conservation as a solution to genetic erosion. Yet the FAO was not a research organization [13], and it lacked the funding and the ability to enact conservation methods. The FAO could not oversee the rise of international agricultural research centers in the 1960s, such as the International Rice Research Institute in Los Baños, the Philippines. In 1971 eighteen international agricultural research centers, organizations, and countries formally joined together and became the Consultative Group for International Agricultural Research (CGIAR), directed by the World Bank, headquartered in Washington D.C. The CGIAR helped FAO reach its goal of long-term germplasm conservation.

The FAO approached the CGIAR in 1971 with the idea of integrating conservation of plant genetic resources into their existing agenda of international agricultural research. The CGIAR and FAO met in 1972 in Beltsville, Maryland, and discussed a global system for plant genetic conservation. The CGIAR relied on plant genetic resources for plant breeding, and it already had some collections of germplasm. In 1974 the CGIAR and FAO formed the International Board for Plant Genetic Resources (IBPGR), which currently operates as Bioversity International.

Under the direction of the FAO's Pichel, the IBPGR, later based outside of Rome, Italy, coordinated the collection, experimentation, and information dissemination of plant genetic conservation projects around the world. The IBPGR partnered with the CGIAR's other international centers and national agricultural research centers to fund and create seed banks. These seed banks had multiple goals: long-term conservation, medium-term experimentation and propagation of germplasm for agricultural research, and short-term field experiments leading to new crop varieties.

In 1975, fewer than ten seed banks existed in the world. This number increased under direction of the CGIAR and FAO, but not without controversy, both within and outside of the IBPGR, about to whom the genetic resources belonged, and about whose responsibility it was to guarantee the security of their storage. The IBPRG changed leadership in 1979, when Trevor Williams replaced R. J. Pichel as executive secretary of the IBPGR. Publication of Pat Roy Mooney's *Seeds of the Earth: Private or Public Resource?* sparked public controversy over access to seed banks.

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