United States Department of Agriculture

USDA Forest Service and USDA Agricultural Research Service

Joint Strategic Framework on the Conservation and Use of Native Crop Wild Relatives in the United States

Forest Service FS-1029 October 2014

Purpose

Recognizing the value of crop wild relatives (CWR) of native plants for crop improvement and providing for the current and future food security of the United States and the world, the Forest Service and Agricultural Research Service, agencies of the U.S. Department of Agriculture (USDA), have developed this strategic framework for collaboration that will help ensure the conservation, evaluation, and use of native CWR occurring on National Forest System lands.

Agency Collaboration

On February 25, 2011, the USDA Forest Service and USDA Agricultural Research Service signed a Memorandum of Understanding (10-MU-11132421-334) formalizing collaboration between the agencies in activities related to the conservation, management, and restoration of native plant species and their habitats and ecosystems.

Further, this strategic framework responds to Executive Order (E.O.) 13603, National Defense Resources Preparedness. Section 201 of E.O. 13603 addresses the responsibilities of Department Secretaries.

> Sec. 201. Priorities and Allocations Authorities.
>
> (a) The authority of the President conferred by section 101 of the Act, 50 U.S.C. App. 2071, to require acceptance and priority performance of contracts or orders (other than contracts of employment) to promote the national defense over performance of any other contracts or orders, and to allocate materials, services, and facilities as deemed necessary or appropriate to promote the national defense, is delegated to the following agency heads:
>
> (1) the Secretary of Agriculture with respect to food resources, food resource facilities, livestock resources, veterinary resources, plant health resources, and the domestic distribution of farm equipment and commercial fertilizer;

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Introduction

Native Plants and Crop Wild Relatives

Crop Wild Relatives (CWR) are native wild plant species that are genetically related to crops, including food, forage, medicinal, ornamental, industrial, and forest tree crops. They are a diverse group of plants that occur in a wide variety of natural habitats throughout the world. Some of them are widely distributed, while others are restricted to very small areas. Some are very common, while others are rare and endangered.

Species of CWR generally have more genetic diversity than the related crop species because they have not passed through the genetic bottleneck of domestication. Many of them have characteristics that allow them to survive under a wider range of environments and stresses than crop plants. Genes from CWR have been used by farmers in crop improvement for thousands of years by encouraging weedy relatives to grow alongside crop plants, allowing natural crossing.

In the early 20th century, Nikolai Vavilov and other early proponents of genetic resources conservation recognized the potential value of CWR in plant breeding. CWR species have been in use in plant breeding programs for many decades, providing genes for improvement to banana, barley, bean, cassava, chickpea, corn, lettuce, oat, millet, potato, rice, sugarcane, sunflower, tomato, and wheat, among others. Some of the traits transferred from CWR to these crops include:

- improved pest and disease resistance
- tolerance to abiotic stresses
- increased yield
- novel cytoplasm
- quality traits

Continuing developments in molecular technologies that make the transfer of traits between species easier improves the prospects for even greater use of CWR in the future.

Khoury, et al. (2013) published a national CWR inventory for the United States. Currently, the list contains 4,600 species from 985 genera and 194 plant families. The inventory includes both wild species that can contribute genetic traits to our crops and those that can be used directly for food, forage, and other uses. In addition to native species, it includes nonnative CWR that have become naturalized in the United States.

Since supporting food security is the primary goal for conserving and managing CWR, the activities within this framework focus on CWR related to food crops.

Nikolai Vavilov

Among the CWR of the United States are the wild ancestors of several domesticated food plants (including sunflower, strawberry, pecan, blueberry, and cranberry) and other species closely related to food crops that originated both in North America and in other areas of the world. Many of these species have proven valuable in modern crop improvement efforts to support American and world agriculture. Native species in the genus *Helianthus* (sunflower) have provided genes for resistance to several diseases, such as rust, downy mildew, powdery mildew, broomrape, Sclerotinia (white mold) head rot and stalk rot, and resistance to insects such as sunflower moth. These genes have been successfully transferred into cultivated sunflower. Resistance to the phylloxera louse (*Phylloxera vitifoliae Fitch*), which first devastated European vineyards in the late 1800s, is provided to this day by using North American grape species, especially *Vitis rupestris*, *V. riparia*, and *V. cinerea* var. *helleri*, as rootstocks. *Juglans hindsii*, native to northern California, is used as a rootstock for orchards of English walnut around the world.

> “supporting food security is the primary goal for conserving and managing CWR”

As with all forms of biodiversity, populations of CWR and the genetic diversity they contain are threatened by factors such as habitat loss and fragmentation, land use changes, pollution, climate change, fire, invasive species, and exploitation. They have often been overlooked when conservation priorities have been set at the international, national, or local level. A major step in advancing the recognition of conservation of CWR as an important issue came in 1961 when a Food and Agriculture Organization (FAO) Technical Meeting emphasized the need to preserve the entire genepools of crops, including their wild relatives.

The worldwide focus on conservation of CWR increased in the 1980s and 1990s. The inclusion of CWR conservation in international treaties (the Convention on Biological Diversity (CBD) in 1992, the FAO International Undertaking on Plant Genetic Resources (later replaced by the International Treaty on Plant Genetic Resources for Food and Agriculture, 2001), and the Global Plan of Action for Plant Genetic Resources for Food and Agriculture in 1996 and 2011) elevated awareness of this issue. The Global Strategy for Plant Conservation 2011–2020, adopted by the Conference of the Parties to the CBD, includes Target 9. Target 9 specifies that 70 percent of the genetic diversity of crops, including their wild relatives and other socioeconomically valuable plant species, are conserved, while respecting, preserving, and maintaining associated indigenous and local knowledge.

Complementary Conservation

In situ conservation refers to the maintenance of reproducing organisms in nature, specifically in the areas where they developed their distinctive properties.

Ex situ conservation refers to the maintenance of germplasm (seeds, pollen, living plants, and plant parts) in human-made sites, such as genebanks and botanical gardens. In situ conservation allows plant populations to continue to evolve and adapt to changing environmental conditions in nature. By preserving entire populations rather than subsamples, a greater amount of genetic diversity can be conserved under in situ conditions than under ex situ conditions. In situ conservation is important as CWR plant populations continue to adapt to changes in environmental conditions, with respect to CWR gene ecology. In situ conservation of CWR contributes to ecosystem services and supports traditional cultural practices. Ex situ conservation is required for purposes of research, ease of access, and secure storage of germplasm. Ex situ collections safeguard plant genetic resources against loss and provide the rapid access to germplasm needed by the research and conservation community. They are, however, often expensive and difficult to maintain, particularly for undomesticated plants that are difficult to regenerate and lack species-specific conservation protocols. The plants do not evolve under natural forces and processes.

Conservation is most effective when a complementary approach involving both in situ and ex situ strategies is employed. The two strategies act as backups to each other and maximize the potential for cost-effective, long-term conservation of alleles, genotypes, and populations.

Mountain Meadow Seeds

Michael (trekr) on Flickr.com

Chiltepin Pepper: "The Mother of all Peppers"

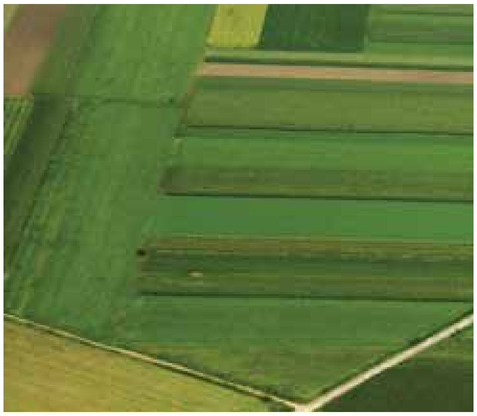
A small, fiery, round wild pepper (*Capsicum annuum* var. *glabriusculum*) is native from Northern South America to the Southern United States. Known as chiltepin, it is an ancestor of hundreds of sweet and hot pepper varieties found in markets and grocery stores today (jalapeno, poblano, mirasol, cayenne, bell, and others). Habanero and Tabasco are two varieties of peppers that did not originate from chiltepin.

Chiltepins are the oldest, as well as the hottest, wild pepper in the Americas. They grow on the rocky surfaces of steep slopes and are difficult to find because they grow in among other shrubs.

The Coronado National Forest in Arizona has reserved 2,500 acres in the "Wild Chile Botanical Area" that provides in situ habitat for the largest population of chiltepin peppers north of Mexico. In situ populations of crop wild relatives provide genetic material for use in crop improvement.

Activities

The main activities within the framework will fall under two general approaches. The first approach will focus on the CWR of a specific crop. The second approach will focus on a specific protected area and the CWR conserved within its borders. Each approach will have an in situ component and an ex situ component. The two approaches are detailed below.



1. Specific crop approach

In situ conservation

Identify a specific crop based on one or more of the following factors: economic value of the crop, National Plant Germplasm System (NPGS) curator-identified need, available resources to accomplish the project, and USDA Forest Service special interest.

Identify that crop's CWR that are native to the United States.

Identify populations of the CWR that occur on USDA Forest Service lands.

Sample selected populations of each of the CWR to measure genetic diversity.

Designate specific populations for each of the CWR as In Situ Genetic Resource Reserves (IGRRs) on USDA Forest Service lands. For evaluation criteria, include ecogeographic zone, population size, sustainability, current level of protection by the USDA Forest Service, ease of access for monitoring and germplasm collection, distance from other IGRRs, and genetic profile (uniqueness, allelic diversity, etc.).

Develop or modify current USDA Forest Service management plans to include the IGRRs using existing guidelines.

Ex situ conservation

Collect propagules (seeds in most cases) and documentation for both medium- and long-term conservation in the NPGS.
a. From all populations designated as IGRRs
b. From sampled populations that have high genetic diversity, but that were considered inappropriate for designation as IGRRs.

Monitor seed viability in medium-term seed storage and re-collect propagules and associated documentation as needed to replenish germplasm supplies.

Documentation

Maintain documentation of all CWR conserved in situ and ex situ on the publicly accessible database of the NPGS (Germplasm Resources Information Network [GRIN], http://www.ars-grin.gov/npgs/index.html).

2. Protected area approach

In situ conservation

Select a protected area managed by the USDA Forest Service for which a plant inventory exists or can be developed.

Identify the CWR for all crops of interest that occur within the protected area.

Designate the protected area as a botanical special area in current USDA Forest Service management plans if deemed appropriate based on number of CWR taxa, significance of individual taxa as resources for food security, uniqueness of CWR taxa, ease of access for monitoring and germplasm collection, and distance from other IGRRs.

Ex situ conservation

Collect propagules and associated documentation from CWR in the protected area when an NPGS curator for one of the related crops has the interest and resources to do so.

Monitor seed viability in medium-term seed storage and re-collect propagules and associated documentation as needed to replenish germplasm supplies.

Documentation

Maintain documentation of all CWR conserved in situ and ex situ on the publicly accessible database of the NPGS (GRIN, http://www.ars-grin.gov/npgs/index.html).

References

Khoury, C.; Greene, S.; Wiersema, J.; Maxted, N.; Jarvis, A.; and Struik, P. 2013. An inventory of crop wild relatives of the United States. Crop Science. 53 (4): 1496-1508. DOI: 10.2135/cropsci2012.10.0585.

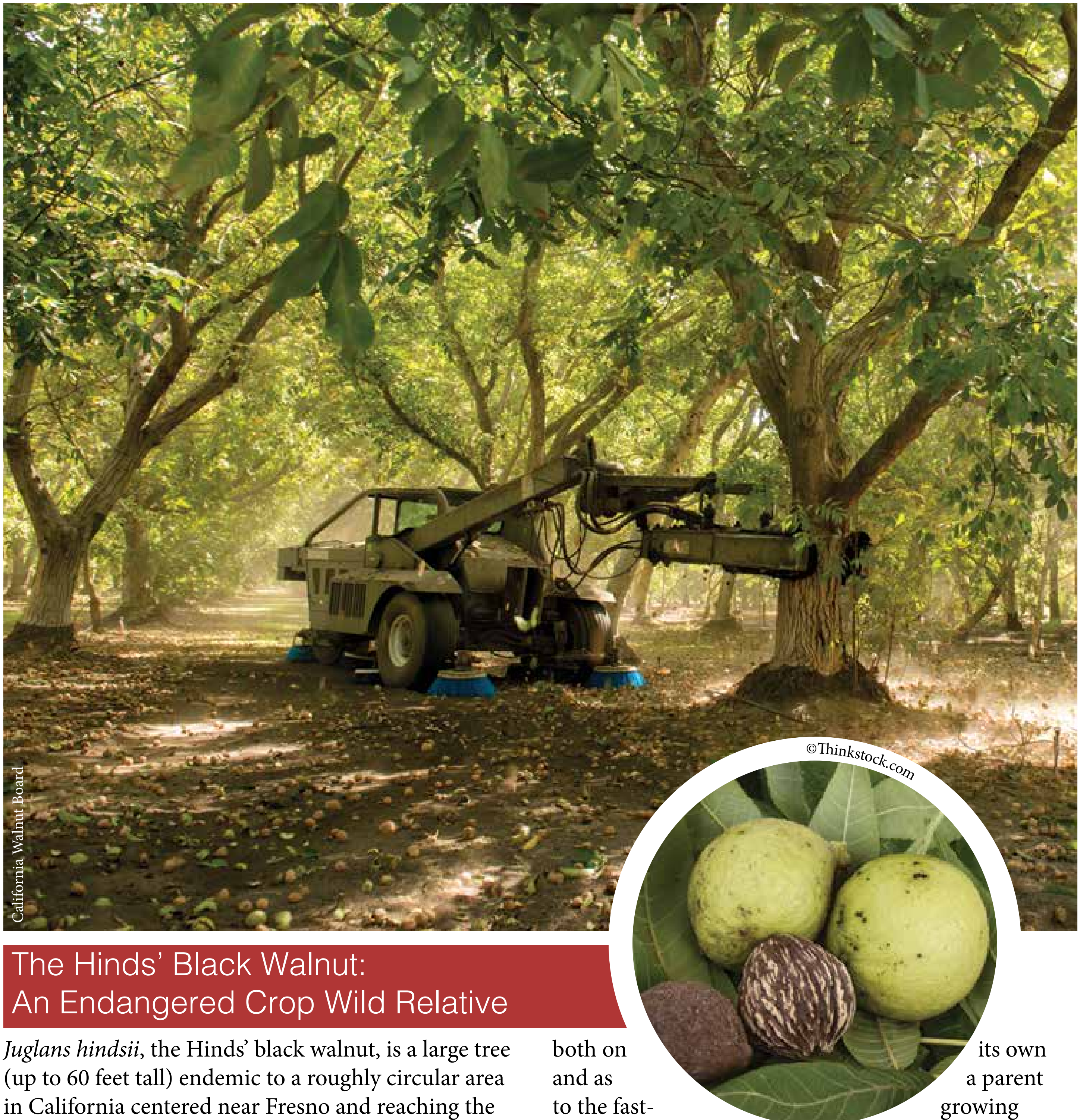
> Conservation is most effective when a complementary approach involving both in situ and ex situ strategies is employed."

The National Clonal Germplasm Repository in Corvallis, OR

The National Clonal Germplasm Repository (NCGR) in Corvallis, OR, is one of the components of the National Plant Germplasm System. This genebank conserves collections of several temperate fruit, nut and agronomic crops, including hazelnuts, strawberries, hops, pears, currants, gooseberries, raspberries, blackberries, blueberries, and cranberries. The collections include both cultivars and wild relatives of the cultivars from around the world. Many of the plants in the collections are clonally propagated, but collections of wild plants are maintained as seed.

The collections are evaluated for useful traits, tested for virus contamination, documented in a public database, and freely distributed to scientists around the world for use in breeding, research, and education. For more information, go to http://www.ars.usda.gov/main/site_main.htm?modecode=53-58-15-00.

The Corvallis repository conserves samples of many of the wild native fruits and nuts found on national forests. These collections provide ex situ backup conservation and can be used to reestablish populations if the need arises. They also provide facilitated access for research to the genetic resources, which furthers scientific understanding and contributes to the improvement of the related crop species.



California Walnut Board

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The Hinds' Black Walnut: An Endangered Crop Wild Relative

Juglans hindsii, the Hinds' black walnut, is a large tree (up to 60 feet tall) endemic to a roughly circular area in California centered near Fresno and reaching the San Francisco Bay area.

J. hindsii is endangered, with possibly only a few native stands remaining. It grows in riparian woodlands, either in single species stands or mixed with California's oaks and cottonwoods.

J. hindsii is commercially important as a rootstock for English walnut *(Juglans regia)* all over the world, both on its own and as a parent to the fast-growing Luther Burbank hybrid, "Paradox" *J. hindsii* x *J. regia*. *J. hindsii* is cultivated as an ornamental tree wherever it will grow.

The wood of *J. hindsii* is commonly called claro walnut by the lumber industry and woodworkers. It is used to make fine furniture, gun stocks, and large, natural-top tables because of its durability, good working properties, and beauty.

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USDA Agricultural Research Service

"Thousands of years ago, Native Americans began cultivating the wild native common sunflower...today, the sunflower is the fourth most important oilseed crop in the world."

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USDA Agricultural Research Service

Sunflower - A Native American Crop

Thousands of years ago, Native Americans began cultivating the wild native common sunflower, *Helianthus annuus L.* Careful selection over hundreds of years produced the domesticated sunflower with single large seed heads and enlarged oil-rich seeds. Today, the sunflower is the fourth most important oilseed crop in the world and is grown in every temperate region.

In all, 52 species of wild sunflowers are native to North America, with the geographic ranges of most limited to the United States. The wild sunflower species are adapted to a wide range of habitats and have much greater variability for many traits than the cultivated sunflower.

Modern sunflower crop breeding programs have used wild species as the source of a number of traits, including resistance to downy mildew, rust, powdery mildew, broomrape, sclerotinia head and stalk rot, and sunflower moth. The estimated economic contribution of the wild species to the cultivated sunflower is between $269 and $384 million per year.

Continued use of the tremendous genetic diversity present in wild sunflower populations is critical to meeting the future challenges of emerging pests and environmental changes that may threaten sunflower production.

Grapes: The Oldest Cultivated Plants

Grapes are one of the oldest cultivated plants—initially cultivated in the Mediterranean area and, then, across Europe and Asia. Scientists have found grapevine fossils that are more than 60 million years old. Humans have used grapes for food and wine since the earliest times.

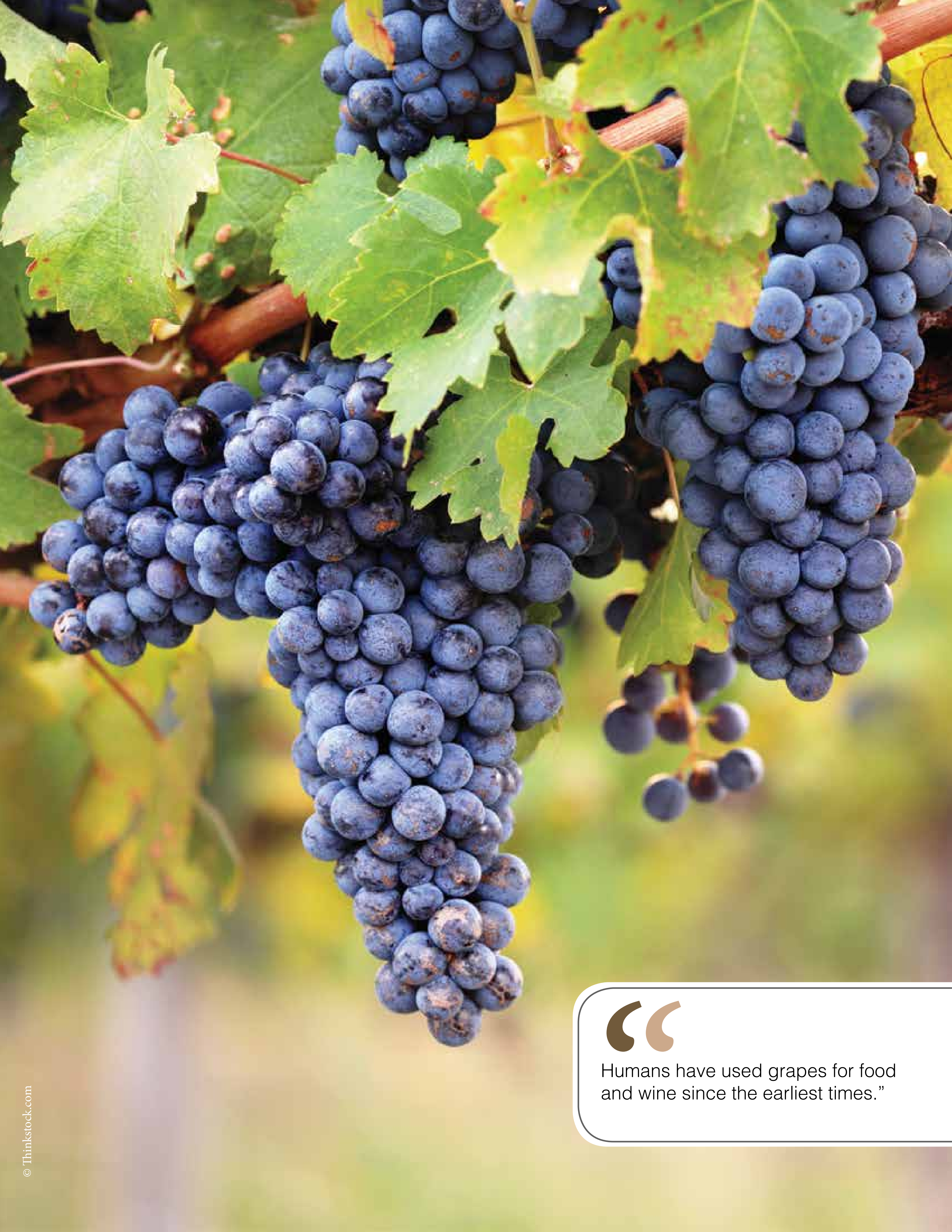
The grapes used in winemaking came from only one species Vitis vinifera, native to the Mediterranean and Asia. Most of the other 50 or so grape species in the world are from North America. Early French colonists in Florida tried many times to introduce and establish Vitis vinifera vineyards. Each time, there was a complete crop failure, and these failures were repeated many times in colonial America. These early French viticulturists never discovered the cause of the crop failure.

> “discovered in 1868...nearly 40 percent of French vineyards had been destroyed”

In the late 17th century and early to mid 18th century, American botanists and naturalists were sending many different species of North American grapes to Europe, especially France. Viticulturists were developing numerous horticultural cultivars. In the mid to late 1850s and the early 1860s, thousands of North American grapevines were being shipped to Europe. A North American aphid, the grape phylloxera, made its way to Europe by 1863. The grape phylloxera attacked *Vitis vinifera* in a manner never observed on North American grape species. On most North American grape species, this aphid feeds on grape leaves forming galls. In Europe, the grape phylloxera attacked *Vitis vinifera* by feeding on its small roots. The aphid injects saliva into the roots and then sucks up the sap. The aphid's saliva is toxic to *Vitis vinifera*. The mystery of why the grapes were dying, however, was not discovered until 1868 when Professor Planchon and his colleagues dug up healthy, dying, and dead *Vitis vinifera vines*. On the “healthy” vines, they discovered grape phylloxera attached to the roots. They discovered that, by the time the vines were observed dying, the aphids had already moved on to their next meal. By this time, nearly 40 percent of French vineyards had been destroyed. Eventually, the grape phylloxera was defeated by grafting *Vitis vinifera* scions on to the phylloxera resistant rootstock of the American species *Vitis riparia*.

By the late 1870s and 1880s, grafting *Vitis vinifera* scions onto an American rootstock, *Vitis riparia*, was generally accepted as the “cure” to keeping *Vitis vinifera* vines alive, healthy, and productive. Thus began the tremendously large and expensive program of reconstituting all the grapevines in France and other European countries by grafting *Vitis vinifera* cultivars on to *Vitis riparia* rootstock.

Today, populations of *Vitis riparia* are managed in situ (in place) throughout its range in the United States to maintain its genetic diversity. If *Vitis riparia* is needed again, scientists will have the crop wild relative to draw upon.



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“Humans have used grapes for food and wine since the earliest times.”

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About the Partner Agencies

Both the USDA Agricultural Research Service and the USDA Forest Service have responsibilities and interests in the conservation and management of native plant species and their habitats and ecosystems.

The USDA Forest Service is a land management agency with the responsibility for 193 million acres of National Forest System lands in 43 States and provides support in the management of the Nation's privately owned forests. As mandated by Federal law and regulations of the Secretary of Agriculture, the agency has major responsibility for conserving biodiversity through the management of fish, wildlife, and plant habitats in forest and grasslands, including providing special protection for threatened, en dangered, and sensitive/rare plant and animal species. The USDA Forest Service accomplishes much of this work by initiating and developing cooperative relationships and effective external partnerships through its National Forest System, Research and Development, and State and Private Forestry branches. The USDA Forest Service implements germplasm conservation almost exclusively by managing and conserving in situ populations. Because the national forests and grasslands are managed for native species, they can be considered "working" germplasm collections.

The USDA Agricultural Research Service manages the National Plant Germplasm System (NPGS), which has the responsibility to collect, maintain, distribute, evaluate, and preserve genetic resources of plant species of interest to the United States. This system is designed to provide, on a continuing basis, the plant genetic diversity needed by public and private plant scientists to improve the productivity of crops and minimize the vulnerability of those crops to biological and environmental stresses. The NPGS currently maintains more than 556,000 accessions representing more than 14,700 species, 2,418 genera, and 228 families. Most agronomic and horticultural crops that are economically important in the United States are actively maintained in the NPGS. Traditional NPGS programs have almost exclusively used ex situ conservation methods, in which the plant germplasm is preserved in genebanks outside of its native habitat.