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Chapter 20

Conservation and Use of the North American Plant Cornucopia: The Way Forward

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Abstract The pages of this extensive book document the potential of a great many North American plants to enhance the productivity, sustainability, and nutritional quality of crops or to be further developed into important cultivated species in their own right. But this potential can only be realized if the plants are adequately conserved to ensure their survival and availability for research, invested in to promote their development, and marketed so as to be attractive to producers and consumers. We outline some of the key steps needed to boost the conservation and use of our regional cornucopia. *In situ* and *ex situ* conservation of North America's useful plants are being accomplished by a variety of institutions with different mandates, but habitat destruction and other threats to wild populations continue to negatively impact many species. Information sharing, coordinating efforts, filling research gaps for wild plants, and increasing support for conservation will be necessary to more comprehensively safeguard these plants and to make them available for use. Technologies enabling more efficient exploration of the diversity within these species are rapidly advancing and offer the potential to contribute to quick advances in improvement of cultivars, but considerable further research and partnerships are needed to

generate and share the results widely. Marketing of new crops can take advantage of the increasing public interest in diverse and nutritious foods, learning from successful collaborations between producers, researchers, and consumers. As a whole, North America already possesses a strong foundation from which the conservation and use of its flora can be enhanced. This includes many protected areas, strong conservation institutions, innovative research, and the willingness to collaborate across fields, institutions, and borders. There are still many silos that need to be broken down and reorganized through innovative partnerships to better conserve and benefit from the North American cornucopia. But given the incredible diversity of interesting and useful plants in the region, the remarkable efforts for many decades by many organizations to care for these plants and share them with humanity, and the increasing public interest in more diverse, healthy, and resilient food and agricultural systems, there is reason for hope.

Keywords: Crop wild relatives, Ex situ conservation, In situ conservation, Wild utilized species

20.1 Introduction

The plants that make up North America's native cornucopia span the full spectrum with regard to recognition of their historic, current, and potential future uses. Maize, or corn (*Zea mays* L.), benefiting from at least 9000 years of keen interest by people (Larson et al. 2014), ranks among the most important plants in the world (Khoury et al. 2014; FAO 2017; Cruz-Cárdenas et al. 2018). Common bean (*Phaseolus vulgaris* L.), chili pepper (*Capsicum annuum* L.), American cotton (*Gossypium hirsutum* L.), sunflower (*Helianthus annuus* L.), pepo squashes (*Cucurbita pepo* L.), avocado (*Persea americana* Mill.), papaya (*Carica papaya* L.), and a handful of other indigenous species also play profoundly important dietary, economic, and cultural roles worldwide (Khoury et al. 2016; Avendaño-Arrazate et al. 2018; Barchenger and Bosland 2018; Doyle et al. 2018; Jenderek and Frelichowski 2018; Kates 2018; Marek 2018). These are North America's most celebrated plant gifts to humanity.

On the other end of the spectrum is a long list of "underutilized" species that, given the equally long set of compounding challenges to the persistence of wild plant populations (Brummitt et al. 2015), may disappear before most of humanity has the opportunity even to be introduced to them. These include many plants that were consciously managed, selected upon, or incipiently domesticated long ago but have fallen to the wayside as casualties of colonialism, agricultural industrialization, globalization, changing cropping preferences, and demographic change (Khoury et al. 2014). Very few of these species benefit from active conservation and breeding programs. Will American potato bean (*Apios americana* Medik), once an important food source both for Native Americans and European settlers from the Atlantic coast to the Missouri River basin (Beardsley 1939), be given the opportunity to reach its potential as a high-protein tuber crop for temperate regions? And what of its beautiful and threatened cousin, traveler's delight (*Apios priceana* B. L. Rob.), which was also once a food source and has now been reduced to a dozen remaining populations due to the destruction of its habitat (USFWS 2015)? The list of such fascinating, essentially wild species with unique potential is long; the outlook for the future is not very bright.

Between these extremes lie a wide range of North American food plants with some relevance within and beyond the region, but relatively minor investment currently with regard to their conservation, breeding, and marketing. Examples include pecan (*Carya illinoinensis* [Wangenh] K. Kochs), cranberry (*Vaccinium macrocarpo*n Aiton), and blueberry (*Vaccinium* section *Cyanococcus*, especially *Vaccinium corymbosum* L.), blackberry (*Rubus fruticosus* L., *sensu lato* and hybrids), wildrice (*Zizania palustri*s L.), cushaw squash (*Cucurbita argyrosperma* C Huber subsp. *argyrosperma*), chayote (*Sechium edule* [Jacq.] Sw.), chia (*Salvia hispanica* L.), tomatillo (*Physalis philadelphica* Lam.), guava (*Psidium guajava* L.), cherimoya (*Annona cherimola* Mill), paw paw (*Asimina triloba* [L.] Dunal), and sapotes (*Pouteria sapota* [Jacq.] H. E. Moore & Stearn, *Casimiroa edulis* Llave & Lex., and *Diospyros nigra* [J.F.Gmel.] Perrier) (Avendaño-Arrazate et al. 2018; Hummer et al. 2018; Kates 2018; Porter 2018; Preece and Aradhya 2018; Volk 2018). Some of these plants, such as jicama (*Pachyrhizus erosus* [L.] Urb.) and sunchoke (*Helianthus tuberosus* L.), are tasty and filling yet of very low-energy density and thus may fill an increasingly important dietary niche in a world of caloric overabundance (The Global Burden of Disease 2015 Obesity Collaborators 2017). Many of these species are rich in vitamins, minerals, and phytonutrients. Also among these "somewhat-utilized" North American plants are numerous nonfood species of economic and cultural importance, including medicinals such as American ginseng (*Panax quinquefolius* L.), cone-flower (*Echinacea* Moench) and black cohosh (*Actaea racemosa* L.) (McCoy et al. 2018); industrial use plants such as jojoba (*Simmondsia chinensis* [Link] C. K. Schneid.), guayule (*Parthenium argentatum* A. Gray), bladderpod (*Physaria fendleri* [A. Gray] O'Kane & Al-Shehbaz), and meadowfoam (*Limnanthes* R.Br.) (Jenderek et al. 2018); fiber plants such as false yucca (*Hesperaloe* Engelm.) and agave (*Agave* L.) (Jenderek and Frelichowski 2018); and many ornamental species, such as those within *Phlox* L., *Coreopsis* L., and *Rudbeckia* L (Jourdan 2018). Virtually all of these plants have both "improved" and wild types distributed in North America. Many are fairly productive without significant inputs and are resistant to pests and diseases. Their contributions to diet, economy, and culture, particularly in other world regions, would very likely expand if crop development and product marketing were given greater investment.

Finally, there are the wild and weedy North American plants that have already, or may in the future, play important roles as genetic resources in increasing the productivity, nutritional quality, and sustainability of agricultural crops cultivated around the world. North America is the home of many progenitors and close relatives of domesticated plants, including those of the important crops listed above that were domesticated hundreds to thousands of years ago in the region, as well as those whose major crop taxa originated elsewhere (e.g., of apples [*Malus* Mill.], cacao [*Theobroma* L.], currants [*Ribes* L.], grapes [*Vitis* L.], hops [*Humulus* L], lettuce [*Lactuca* L.], onions [*Allium* L.], quinoa [*Chenopodium* L.], strawberries [*Fragaria* L.], and walnut [*Juglans* L.]) (Brenner et al. 2018; Heinitz 2018; Hummer et al. 2018; Lebeda et al. 2018; McCoy et al. 2018; Preece and Aradhya 2018; Volk 2018). There are also thriving populations of introduced relatives of important staples (e.g., of wheat [*Aegilops* L.], oats [*Avena* L.], and sugar beets [*Beta* L.]), which have diversified within the region sufficiently to have become interesting to plant breeders as sources of agronomically valuable traits (Khoury et al. 2013).

As a whole, there are many thousands of crop wild relative species distributed across North America (this book; USDA, ARS, National Plant Germplasm System 2017b), with at least a couple hundred being of particular interest due to their relatively close genetic relationship with major crops, making introgression of useful traits quite feasible (Khoury et al. 2013). Of these, the native sunflowers as a group have probably been of greatest use in crop breeding thus far, particularly for pest and disease resistance (Dempewolf et al. 2017; Seiler et al. 2017; Marek 2018). Other celebrated examples include North American wild grapes' contribution to resistance to phylloxera (*Phylloxera vitifoliae* Fitch) in European rootstocks (late 1800s to present) (Khoury et al. 2013; Heinitz 2018) and the use of native wild hops (*Humulus lupulus* L. var. *lupuloides* E. Small) in the breeding of important European cultivars (Townsend and Henning 2009; McCoy et al. 2018). Breeding efforts that have made important contributions to crop improvement through the use of North American wild genetic resources have been located not only in the region but also in Europe, Asia, Australia, and elsewhere (e.g. sunflower breeding, reviewed in Marek 2018).

Yet despite these successes, and even while crop wild relatives have gained increasing visibility within the texts of international agreements on agriculture, development, and conservation (e.g., Sustainable Development Goal Target 2.5 [United Nations Sustainable Development Platform 2016]; Aichi Biodiversity Target 13 [Convention on Biological Diversity 2016]; and the International Treaty on Plant Genetic Resources for Food and Agriculture [Plant Treaty], Article 5 [FAO 2002]), the great majority of North American wild and weedy genetic resources certainly fall on the underappreciated end of the spectrum with regard to recognition of their potential value. Introgression of useful traits from wild relatives and the elimination of linkage drag of non-useful traits are, in comparison to the status quo use of improved domesticated germplasm, challenging and lengthy processes. Such useful traits are often masked in the wild types (Tanksley and McCouch 1997), making predictions of their value difficult. And many taxa are common and weedy in form and thus catch the eyes and capture the hearts only of the most enthusiastic of botanists and land managers. These are some of the historic reasons why crop wild relatives have not, in general, been given major priority within the strategies of the crop improvement, genetic resources conservation, and land management communities. This needs to change, as the use of wild relatives in crop breeding is gaining momentum (Guarino and Lobell 2011; McCouch et al. 2013; Dempewolf et al. 2017) to help address serious agricultural production challenges (Lobell et al. 2008; Cordell et al. 2009) and because threats to their natural populations are compounding (Castañeda-Álvarez et al. 2016).

The pages of this extensive book document a great many North American plants that could contribute much more to human culture than they currently do. But only, of course, if they are adequately conserved to ensure their survival and availability for research, invested in to promote their development, and marketed so as to be attractive to producers and consumers. Below we outline some of the key steps that we have identified as needed to boost the conservation and the use of our regional cornucopia.

20.2 Conservation

20.2.1 In Situ

Federal, state, and other official threatened and endangered species lists provide a primary medium by which conservation investment can be both acquired and defended and should be advocated for and enforced wherever possible. A worrying number of North American crop wild relatives are already listed as threatened or endangered (e.g., 62 wild relative taxa native to the USA are listed endangered under the Endangered Species Act, 10 taxa as threatened, and 11 as candidates for listing; and NatureServe assessed 8 US wild relative taxa as known or presumed extinct in the wild, 115 as globally critically imperiled, 111 as imperiled, and 337 as vulnerable) (Khoury et al. 2013). Many of these conservation assessments were completed a decade or more ago and are in need of re-evaluation, given the compounding threats to wild plants from habitat destruction and degradation, invasive species, overharvesting, and climate change (Brummitt et al. 2015). Furthermore, a considerable proportion of North American wild relatives have not yet been fully assessed for threats to their natural populations, even while the available literature gives much cause for concern (e.g., dire warnings for the last remaining populations of the wild progenitor of maize [Wilkes 2007]).

Fortunately, independent of the long and complicated processes required to successfully place plants on official threatened species lists, *in situ* conservation of North American crop wild relatives and other wild utilized plant species is occurring in federal, state, provincial, Native American, First Nations, Indigenous peoples, nongovernmental, and privately managed protected areas. Aside from a handful of designated conservation programs for iconic wild relatives (i.e., US Forest Service wild chili [*Capsicum annuum* var. *glabriusculum* (Dunal) Heiser & Pickersgill] preservation activities in Southern Arizona, USA [USDA Forest Service 2016]; and the management of a wild relative of maize [*Zea diploperennis* H. H. Iltis et al.], various wild beans, and other crop wild relatives in the Sierra de Manantlan Biosphere Reserve in Jalisco/Colima, Mexico), such conservation is essentially "passive" (i.e., without active management plans for individual species or populations and without regularly scheduled monitoring). Because of this, information on the status of populations of most of these plants in most protected areas is not available, and it cannot be assumed that these populations are thriving.

Major steps forward in the active *in situ* conservation of crop wild relatives and wild utilized species in North America could be taken by improving the documentation of the status of populations persisting in existing protected areas, sharing this information on one or a few common platforms, and enhancing the monitoring of populations identified through the process as being unique and valuable. While such efforts would require additional investment in staffing and information technologies, the resources needed would almost certainly be a fraction of those required to fulfill obligations enforced for officially listed threatened and endangered species and would be more politically achievable across the different organizations, landowners, and countries. Such initiatives would also provide more flexibility for land managers to achieve conservation goals in their own manner and aligned with their own sets of priorities and would thus probably represent more sustainable arrangements for long-term regional collaborations on conservation of useful wild plants.

20.2.2 Ex Situ

Information on *ex situ* collections for North American crop wild relatives and wild utilized plants is generally available and relatively easy to access for public genebanks and to a more limited degree for botanic gardens. Data on university, private, nonprofit, local seedbank, and other *ex situ* collections are not nearly as accessible. Previous assessments of the representation of crop wild relatives in *ex situ* conservation systems have provided an indication that there are serious gaps for North American taxa (e.g., Castañeda-Álvarez et al. 2016). However, these findings are incomplete in their coverage of institutions performing *ex situ* conservation, largely due to lack of access to the pertinent data on existing collections. This is unfortunate, as some of these nongovernmental collections may be playing significant conservation roles, particularly for useful wild food plants, and deserve fuller recognition.

Parallel to the priorities for *in situ* conservation, comprehensive information on *ex situ* collections for North American wild plants, shared on one or a few centralized online resources and including as many collections as possible both within and beyond the region, represents a critically important priority to enable a full assessment of the state of conservation of such taxa and to identify the regional gaps in their representation *ex situ*. Such coordinated information resources also provide a primary medium by which useful information on these plants can be shared with plant breeders and other researchers and furthermore can bolster the justification of investment in conservation from a rational, regionally coordinated perspective.

Data management programs under development or being utilized by genebanks (e.g., GRIN Global [USDA, ARS, National Plant Germplasm System 2017a] and Genesys [Data Providers and the Crop Trust 2017]) and by botanic gardens (e.g., BG-BASE [BG-BASE Inc. 2017], IrisBG [Botanical Software Ltd 2017], and BGCI PlantSearch [Botanic Gardens Conservation International 2017]) in the region have many years of investment and could be used to combine and share such information but require modification to be able to receive inputs from institutions which have managed their data using different technologies. In some institutions, collections and associated provenance data have been purposely obscured from the public for fear of theft of specimens in botanic and public gardens or because the information could lead to overharvesting of specimens from the wild. Thus information sharing also needs to be accomplished with attention paid to potential risks to species, especially those with few remaining populations persisting *in situ*.

A detailed regional analysis of the representation of North American crop wild relatives and wild utilized species in *ex situ* conservation is needed to identify those taxonomic groups and geographic regions least well protected and to provide focus for efforts to overcome the funding and political challenges to improving their conservation. National inventories of useful wild plants have already been completed (Khoury et al. 2013) or are under development (Contreras-Toledo et al. 2018), and these in combination with updated high-quality taxonomic (USDA, ARS, National Plant Germplasm System 2017b) and floristic (e.g., Flora of North America Association 2008) information, and an increasing availability of occurrence (e.g., GBIF 2017) and ecogeographic data (e.g., Fick and Hijmans 2017; Hengl et al. 2017) and modeling tools (e.g., Phillips et al. 2017) make the completion of a high-quality regional analysis possible. Inputs by field botanists and conservation practitioners ground-truthing species occurrences will be critical to ensuring that the analyses reflect real distributions, especially for species whose ranges have changed dramatically in recent decades (e.g., rock grape [*Vitis rupestris* Scheele] [Heinitz et al. 2018] and various wild cotton species [*Gossypium* L.] [Jenderek and Frelichowski 2018]).

Such an analysis could additionally be adapted for use in assessments of the state of wild plants conserved *in situ* in existing protected areas, forming in combination a truly comprehensive conservation analysis for the North American plant cornucopia. Following from these assessments, coordinated collecting for *ex situ* conservation of gaps in collections, and the creation of or enhancement of existing management plans for wild populations in protected areas, can be prioritized and initiated.

The information compiled in this book on existing *ex situ* collections of seeds, buds, other propagules, and whole plants conserved in the national public genebanks, botanic gardens, universities, and other institutions reveal a diverse array of banked resources that are often the result of decades or indeed lifetimes of efforts of dedicated botanists, curators, and plant breeders. The collections of relatives of major commodity crops, such as those of sunflowers and North American wild potatoes (*Solanum* L.) are comparatively the most well represented and documented, both taxonomically and geographically. The wild relatives of minor crops and the many underutilized North American wild species are much more sparsely represented.

Furthermore, even the most comprehensive collections still have recognized gaps with regard to representation *ex situ* of the full array of taxonomic, geographic, and genetic variation in extant wild populations. One of the reasons for these persisting holes in major collections is that many species groups are distributed in more than one country, thus requiring coordination between nations. Part of the challenge results from the very complicated policies regarding biodiversity and the sharing of genetic resources, which are being negotiated primarily via the Convention on Biological Diversity (CBD) (Convention on Biological Diversity 2017), the Plant Treaty (FAO 2002), and the Nagoya Protocol of the CBD (Buck and Hamilton 2011). These agreements provide international frameworks for collaboration across borders, but at the current time, each of the countries in North America differs in membership status (de la Torre et al. 2018; Diederichsen and Schellenberg 2018; Williams and Greene 2018). Moreover, considerable further efforts are needed to implement these policies in North America in standardized and clear ways such that they are understandable to collectors, conservationists, researchers, and political authorities.

For such reasons, large publicly accessible genebank collections for wild relatives of crops such as sunflower (e.g., threatened species such as Algodones sunflower [*Helianthus niveus* (Benth.) Brandegee subsp. *tephrodes* (A. Gray) Heiser] and paradoxical sunflower [*Helianthus paradoxus* Heiser]) are incomplete in the sense of lacking representation *ex situ* of the entire diversity of populations identified by experts as important from both Mexico and the USA (Marek 2018). As access to genebank collections maintaining plant genetic resources at high standards is useful to researchers in all of the North American countries, as with elsewhere around the world (Hoisington et al. 1999; Gepts 2006; Khoury et al. 2016), the region should actively work to improve the ways that wild plants can be conserved and exchanged internationally.

Various challenges to the success of *ex situ* conservation efforts for North American wild plants are apparent. The initial processing activities required to maintain a high degree of viability during storage, the placement of the species in conditions that enable their survival over long periods, and the periodic regeneration/multiplication of accessions are all generally more challenging and more expensive for wild plants than for crops. Research at the species and even at the population/accession level is often needed to develop appropriate protocols (Hellier 2018; Walters et al. 2018), particularly for challenging taxa such as the wildrices (*Zizania* L.) (Porter

2018). Some plant species, especially the perennials, can be maintained as specimens in botanic gardens or in conservation fields to avoid some of these challenges, but available space and management costs constrain the ability to curate a broad range of infraspecific diversity with these methods.

While these research and curatorial challenges are all surmountable from scientific and technical perspectives, they persist due to insufficient resources devoted to wild plant conservation *ex situ*. Investment in public national and other repositories has, in general, declined in recent decades, especially when understood in light of increasing costs, particularly for distribution of materials (Fu 2017). Funders increasingly want evidence of social impact. Unfortunately, beyond documentation of the number of distributions made, the impact of using plants distributed from genebanks is not currently readily determinable, as breeding by the private sector is generally proprietary information and as utilization even by the public sector is rarely easily accessible. An information system under development by the Plant Treaty (FAO 2002) may help to provide more thorough documentation of the use of some of North America's native wild relatives in the future, but the data is unlikely to be comprehensive, and the lag time between requesting of materials from genebanks and release of crop varieties is often many years or even decades, giving this feedback cycle dubious power to bolster arguments for improved maintenance of *ex situ* collections.

The need for greater support for public genebanks and other *ex situ* facilities committed to the conservation and distribution of useful plant diversity has been highlighted for decades (Hoisington et al. 1999; Esquinas 2005). Keeping distributions free to plant breeders and other researchers is a laudable value and an important means of recognizing that crop wild relatives and wild utilized species are public goods that should remain openly available for the benefit of humanity (Gepts 2006). How to improve the support of these institutions remains a perennial challenge (Fu 2017). Advocacy by the larger conservation community and by public and private users of the conserved genetic resources could be strengthened through coordinated efforts (Gepts 2006; Guarino and Lobell 2011). Furthermore, given the relatively low level of awareness in the public of the importance of genetic resource conservation to agriculture, efforts to increase this awareness could be helpful (Novy and Moreau 2018).

20.3 Improvement and Marketing

20.3.1 Documentation, Characterization, and Evaluation

Crop wild relative and wild utilized plant accessions conserved *ex situ* in the North American public genebanks and other genetic resource collections range in the degree of existing and available documentation, characterization, and evaluation data. In general, most have basic documentation with regard to taxonomy and origin (i.e., passport data) but have little available characterization and only in exceptional cases evaluation data. "Offline" datasets curated by academic researchers and by the private sector may provide further valuable information on these accessions but are not currently widely accessible.

Useful data on such species is being generated more efficiently via ecogeographic modeling, high-throughput characterization and evaluation, and genomics, generally by way of crop genepool or trait-specific projects. These efforts lack a coordinated mechanism to pool and make such data easily accessible, constraining greater use and also more sophisticated conservation of this diversity (Gur and Zamir 2004; Dempewolf et al. 2017). Incentivizing organizations and individuals not only to generate but also to share data should be prioritized so that this information can be put to use by plant breeders and genetic resource conservationists (Volk and Richards 2011, McCouch et al. 2013).

Building on the existing national efforts to inventory wild relatives and wild utilized species and taking advantage of available documentation, characterization, and evaluation data, national and regional lists of species with significant potential for development as genetic resources or as new crops should be completed and advocated for within organizational research priorities. These efforts are important foundational steps toward producing new crops and new varieties adapted to target climates and soils and filling target market niches.

20.3.2 Pre-breeding and Breeding

Incorporating useful traits from wild relatives into crop cultivars can be facilitated by pre-breeding, the process of crossing exotic genetic resources with modern breeding materials in order to generate offspring that contain novel useful diversity which can be incorporated more easily into advanced plant breeding programs (Prohens et al. 2017). Pre-breeding has historically been performed mostly by public organizations, but these efforts have declined in recent decades due to funding limitations (Morris et al. 2006). Renewed support is thus very much needed for public programs and for public-private partnerships that tackle the initial challenges of introducing traits of interest from wild relatives into domesticated materials and making these materials available to the public (Guarino and Lobell 2011).

The decline in investment in public breeding programs within governmental and in academic institutions has also affected the breadth of crops of primary development focus, generally narrowing this focus further on important commodity crops, and in turn abandoning the riskier longer-term projects directed toward turning promising wild utilized species into productive crops (Fuglie and Walker 2001; Morris et al. 2006; Pardey et al. 2016). Given that the suite of crop plants underlying the global food system has become increasingly homogeneous (Khoury et al. 2014), making greater space in agricultural research investment for the plants with the greatest potential to make agricultural production and the human diet more diverse is prudent. Such efforts can be supported by stimulating diversification research, engendering research arrangements that enable the open distribution of promising new varieties while providing appropriate acknowledgement to individuals and organizations, providing production support via agricultural extension and training, and further developing seed systems facilitating the multiplication and distribution of seed and other propagules to growers (Naylor et al. 2004; Khoury and Jarvis 2014; Rotz and Fraser 2015).

In recent decades, major advances have been made in the sophistication of tools used to identify functionally useful diversity in plants and to introgress traits from these sources into improved varieties. Many of these tools could enable rapid domestication advances in wild utilized species, for example, by helping to overcome biological constraints such as flowering time or daylength sensitivity, agronomically challenging growth habits, or the uneven maturation of fruits or seeds (Naylor et al. 2004; Runck et al. 2014; DeHann et al. 2016). Some of these tools can provide valuable additions to conventional plant breeding programs. Others, such as the introgression tools that help move genes between exotic sources and the emerging techniques enabling the "editing" of genes based on a thorough knowledge of the genome of species or of related plants (Zhang et al. 2014), are subjects of strong public opinion and complicated policy (Jordan et al. 2017). Their potential to contribute to the diversification of food systems is dependent on the ways breeding targets are chosen and the benefits of the research are shared, as well as the manner by which research is performed and communicated to the public (Naylor et al. 2004; Jordan et al. 2017).

20.3.3 Marketing

The relatively recent expansion in global harvested area and increase in consumption worldwide of crops such as quinoa (*Chenopodium quinoa* Willd.) and chia provides evidence that agricultural production and food supplies can be diversified through research, within a climate of growing consumer interest in healthier and more varied food alternatives. Local food, regionally adapted food, and organic food movements are long-term trends which provide opportunities for growers to be profitable with new, niche, or value-added crops. Both private and also public organizations promoting new foods are becoming more sophisticated in their ability to influence markets, both by way of traditional advertising and via social media, collaborations with recognizable advocates (such as celebrity chefs), and innovative packaging of such foods to fit modern lifestyles which value convenience (Beans 2017). Further efforts to diversify food systems with North American plants should learn from these successes. Increasing public demand for foods and other agricultural products of North American origin will be critical to any significant progress in increasing the use of this diversity, as the region currently primarily produces and consumes plants of foreign origin (Khoury et al. 2016).

20.4 Final Remarks

North America is remarkably well positioned to more comprehensively conserve its native plant cornucopia and to use these plants to diversify the food that is eaten and the crops that are used for fiber, industrial purposes, medicine, ornamentals, and other purposes, both within the region and around the world.

Canada, Mexico, and the USA have existing legislation that provides protection for threatened plants and a significant number of public and other managed lands that are functioning to safeguard species *in situ*. National genebank systems have the appropriate infrastructure and working information systems and a long record of regional collaboration (e.g., via the North American Network on Plant Genetic Resources [NORGEN] [PROCINORTE 2015]). Annual distributions to plant breeders and other researchers around the world by the USA and Canadian genebanks count among the largest worldwide, and all of the national genebanks in the region serve important within-country distribution functions. Many hundreds of botanic and public gardens are distributed throughout the region, providing not only conservation functions but also important opportunities for the public to interact with these plants (Moreau and Novy 2018). A range of local, nonprofit, and community-based initiatives also play conservation roles. National and international policy on the conservation and sharing of wild plants is actively being negotiated. Crop wild relative and wild utilized plant inventories have been completed for most of the region. Collaborations across organizations, countries, and fields, from agricultural research to botanic gardens to land management agencies, are being created and strengthened (e.g., USDA Forest Service and USDA Agricultural Research Service 2014).

There are still many conceptual, organizational, and political silos that need to be broken down and reorganized through innovative partnerships to take the major steps forward needed to better conserve and benefit from North American crop wild relatives and wild utilized plants. But given the incredible diversity of interesting and useful plants in the region, the remarkable efforts for many decades by many organizations to care for these plants and share them with humanity, and the increasing public interest in more diverse, healthy, and resilient food and agricultural systems, there is reason for hope.

Thomas Jefferson, one of the founding fathers of the USA, an avid gardener, and a passionate advocate for food crop diversity, said in 1800 that "The greatest service which can be rendered to any country is to add a useful plant to its culture." Given the very real and pressing need to make food systems around the world more nutritious and more sustainable, an expanded version of Jefferson's words continues to be relevant. We hope that this book contributes to increasing the interest in, and bolstering the efforts devoted to, adding well-conserved useful North American plants to global culture.

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