Wild Food Plants

Subjects: Plant Sciences
Contributor: Teresa Borelli

Wild food plants (WFPs) are generally considered species that grow spontaneously in self-sustaining populations outside cultivated areas, in field margins, forests, woodland, grassland, and wetlands (e.g., paddy fields), independently of human activity. However, the distinction between “wild” and “cultivated” or “domesticated” is not so clear-cut and many wild food plants fall somewhere in between these two extremes depending on the degree of human intervention and management. Semi-domesticated species, in addition to economically important non-timber forest food products, such as açaí berries and Brazil nuts, can also be considered "wild" to some extent as they grow naturally in forest with limited management or human intervention. As they are often wild relatives of domesticated species, WFPs have potential for domestication and can provide a pool of genetic resources for hybridization and selective breeding.

Keywords: Wild food plants ; Food and nutrition security ; conservation ; food policy

---

1. Introduction

The practice of consuming wild food plants (WFPs) is as old as human prehistory. Early humans obtained their food by hunting, fishing and gathering these plants, or parts of plants (e.g., stems, roots, flowers, fruits, leaves, buds, and seeds), that were safe for human consumption. It was not until 10,000 years BC that people started settling into more permanent homesteads and domesticating plant species (mostly carbohydrate-rich staples) while maintaining some hunter-gatherer activities and collecting WFPs from the wild [1][2]. This still holds true for some traditional horticultural societies today (e.g., the Machiguenga in South America) [3]. All of the plants we now call domestic crops were once WFPs, altered by human manipulation to achieve domestication by selecting more favorable plant traits. With plant domestication and farming came also the development of weeds; that is, unwanted plant species in cultivated fields, and many of the WFPs consumed today include relatives of today’s crops.

Wild food plants can grow spontaneously in areas that are or have been themselves cultivated [4][5], or, as in the case of the “quelites” greens in Mesoamerica (e.g., the genus Amaranthus, Chenopodium, Porophyllum, Portulaca, Crotalaria, and Anoda), they have become the focus of systematic in situ management practices such as “selective harvesting” and “let standing”, with important repercussions on plant communities [6]. Another known management practice is that of “encouraging growing” recorded by Cruz-Garcia [7] in the Peruvian Amazon along the deforestation border. Surveys revealed that, out of 30 wild food plant species identified, 20 are actively managed by local farmers and that most are transplanted from the forest to their agricultural fields for easy access. From these, 57% of the species are classified as weeds, yet are perceived by farmers to play a role in food security, particularly with increasing deforestation and reduced availability of food plants [7].

2. The Importance of Wild Food Plants Today

WFPs continue to play a vital role in the subsistence of many human populations particularly when the availability of food crops is scarce, when household budgets are insufficient to buy enough food or when access to markets is challenging [5][8][9][10][11][12][13][14][15]. Wild foods are also integral to traditional food systems and have nutritional and cultural value for many indigenous peoples [4][5][16][17]. Deeply connected to their land, indigenous peoples, who represent 5% of the global population [18], are often the sole custodians of rich and diverse knowledge relating to plant uses and traditional food systems and to local food biodiversity existing within the ecosystems they inhabit [17]. Traditional communities also have better ecological knowledge about local environments and their customary users, making monitoring and regulating of natural resources easier [19] (Figure 1).

Figure 1. A wild food plant.

Although the caloric contribution of WFPs to people's diets is generally low compared to staple foods [20], these species contribute to diet diversification in many geographical settings where otherwise monotonous diets may prevail [21][22][23][24][25]. Wild foods (both plants and non) provided between 1% and 19% of the iron consumed, between 5% and 45% of the calcium and between 0% and 31% of the vitamin A equivalents (RAE) in the diets of women and children in studies from Benin, Tanzania, and the Philippines [20]. These neglected biological resources have, in fact, been shown to contain equally, if not higher amounts, of nutrients than more widely available commercial crops [5][26][27][28], and, if properly assessed and managed, could be introduced in national food and nutrition security and sovereignty strategies that focus on nutrient adequacy rather than quantity of staples, while being culturally acceptable.

WFPs could also be central to efforts directed at empowering local market actors as well as reducing the distance between consumers and producers and the overreliance on globalized value chains. Although, recent research by Kinnunen et al. [29] highlights the unfeasibility of localizing production for important global staples such as rice, maize and temperate cereals, there is increasing evidence that the local trade of minor crops, traditional varieties, and WFPs has potential to empower communities and increase livelihoods in rural areas, particularly of women and youth [30][31]. Meanwhile, the COVID-19 crisis has revealed the vulnerability of our global food systems to disease-related disruptions and shocks [32][33][34]. For example, the imposed travel restrictions on people and goods as a result of the lockdowns are causing logistical bottlenecks in food supply chains [35]. Given the national and international trade restrictions, long supply chains are struggling to cope with the rise in food demand for non-perishable food supplies [36], while short supply chains are suffering due to the closing of informal and local open-air markets [37], where the majority of the world's population still obtains fruits, horticultural, and other perishable products [36][38]. At the same time, the pandemic has opened up opportunities for a new food system paradigm that supports local self-sufficiency and domestic agricultural production and sees home and community gardens, traditional agroecosystems, and farmers' markets as essential services [37][39]. With food shortages affecting specialized, high value horticultural crops [40], people are turning to traditional vegetables and WFPs as a sustainable source of food, vitamins and nutrients [41], not to mention for herbal ingredients, traditional medicine formulations or new biopharmaceuticals [37][42][43].

3. Threats to WFPs

Despite the realization of the potential use of WFPs in food security and poverty reduction strategies, FAO's State of the World on Biodiversity for Food and Agriculture (SOWBFA), along with other recent global reports [44], warn us that this diversity is fast disappearing, particularly in forest habitats [45][46]. Land use changes (e.g., conversion to agriculture, change in agricultural practices and infrastructure development), habitat destruction (resulting from timber harvesting, fuelwood collection, grazing, and forest fires) and overharvesting collectively account for 62% of the threats reported to WFPs in SOWBFA, which mostly grow beyond the limit of protected areas [47][48][49].

The SOWBFA used the Sampled Red List Index for Plants of the International Union for Conservation on Nature (IUCN) [50] to determine that, of a total 822 WFP species considered across 7 different classes, 73% are currently at low risk of extinction (Figure 1), with some classes highly threatened in the wild (e.g., WFPs that are derived from conifers and cycads). However, the IUCN Red List Index for Plants includes global conservation assessments for only one third (31%) of known WFPs. Local assessments for many WFPs that are currently excluded from the IUCN assessment paint a very different story indicating the need to consider community perceptions when ascribing risk class. Furthermore, an assessment of the comprehensiveness of conservation of 1587 WFP taxa (including cereals, fruit, and nuts), carried out by the International Center for Tropical Agriculture (CIAT) as part of a larger study to identify conservation gaps for useful plants, shows that only 3.3% of WFPs are sufficiently conserved ex situ, i.e., in gene banks or in other living plant repositories, while 89.1% require urgent off-site conservation measures given the impending threats to their existence [51]. Their continued use in diets, when accompanied by careful sustainable management by the communities consuming them, and protection of WFP habitats, on the other hand, seems to have ensured their momentary conservation in situ, in the natural habitats in which they grow. Of the WFP taxa analyzed 42.1% are sufficiently conserved, 46.7% deserve medium priority and 11.1% require stepping up conservation measures [51]. Nonetheless, Khoury et al. [51] caution against the overreliance on protected areas for the long-term conservation of these species. Rapidly warming temperatures and habitat destruction can alter the species' geographic distribution, driving them across the artificially designated boundaries of many protected areas in pursuit of favourable growing conditions [52].

4. Barriers to Greater Use of WFPs

The disregard of WFPs for food security and nutrition can be partly attributed to a lack of evidence and awareness among policymakers and other stakeholders of the importance of wild foods to diets, livelihoods, and food security, coupled with a number of market and non-market barriers limiting their untapped potential.

Underpinning the lack of recognition for WFPs is also limited or short-term research and extension funding to support the exploration of non-conventional, traditional and indigenous food resources. Many of these barriers were summarized by Heywood [4] and are still very much valid today:

- lack of information about the extent of their use and importance in rural economies;
- lack of information, especially statistics, concerning the economic value of WFPs;
- lack of reliable methods for measuring their contribution to farm households and the rural economy;
- lack of information on the sustainability of current harvest levels;
- poorly developed infrastructure and markets for WFPs, with the exception of small number of products (e.g., Açaí berries);
- unevenness of supply;
- lack of quality standards;
- general lack of storage and processing technology;
- availability of substitutes;
- policies and research mostly favoring commodity crops and commercial agriculture.

Like other neglected and underutilized species, additional barriers to the promotion of WFPs in food production and consumption patterns include: limited and fragmented data of the nutritional importance of these species; fragmented data on the quality and nutritional impacts of WFPs on household nutrition [53]; and knowledge gaps on the species' biology and ecology to develop domestication and management strategies [44][47].

Unfavorable and disabling national policies, coupled with the many stakeholders and interests involved, represent an additional obstacle to greater recognition for WFPs. The main policy barriers were identified and summarized by the Strategic Framework for Underutilized Plant Species [54], of which WFPs are part of. These are provided in Table 1 below.

Table 1. Barriers that hinder the improvement of national policy frameworks towards supporting WFPs.

Awareness	Focus	Financial Support	External Pressures
No adequate data	Mismatch with national priorities	No international financial or donor support	International trade favor R&D on conventional crops
Lack priority in education and information systems	Limited capacity (institutional, research) to work with WFPs	Weak economies for investing in R&D for WFPs	International R&D priorities influence national priorities

Further contributing to the demise of WFPs, is the low recognition of value and perception of these foods as being "women's food"[55] "food for the poor" or "famine foods" to be harvested only when staple crops fail, as well as lack of institutional capacity to mainstream this diversity into national production and consumption patterns [27]. On the other hand, in some regions, such as West Sumatra, communities perceive WFPs positively, but the main barrier to their greater use is their reduced availability caused by land degradation and agriculture intensification [56]. In many places, traditional wild leafy vegetables are disappearing from local diets due to changing dietary patterns and preferences driven by globalization and increasing market integration [57]. Wild leafy vegetables (WLV) and wild food plants in general are undervalued and seen as "un-modern" in Morocco, Turkey [27][55], and many other parts of the world. This lack of value places the role of WFPs in the diet at risk, although it may ease pressures on overharvesting. In Brazil and Kenya, changing dietary patterns and lifestyles has reduced the diversity and availability of wild fruit and vegetables in market settings, which focus instead on a limited number of exotic crops [58]. This has led to people consuming sub-optimal diets that are increasingly unhealthy, unsustainable, and inequitable for many populations [59].

5. An Integrated Conservation Approach

Because they exist on a continuum of human management, from truly wild to semi-domesticated [7], and because the germplasm and other plant material (e.g., tissue, embryos etc.) of some species may not be suitable for ex situ conservation [60], both in situ and ex situ conservation should be combined for optimal results [61][62][63]. In situ conservation strategies can complement ex situ conservation and allow WFPs to continue to evolve adaptive traits in their natural environments while benefiting those who need them most, particularly in areas where high diversity, rural poverty and malnutrition coexist.

Above, we have identified an array of threats to WFPs including: land use changes, deforestation and degradation; agricultural change, intensification and chemical input use; overharvest or unsustainable harvesting; loss of traditional management practices that communities used to promote the production of wild food plants (for example, pruning and burning); and climate change. We also identified a range of barriers that are contributing to the loss of use and value for WFPs, such as, lack of information (diet, nutrition, safety economics, and ecological); lack of harvest, storage and value chain tech and infrastructure; and lack of awareness, education and inclusion in policy and programming. In the subsequent sections of this paper we propose a set of best practice actions that can be taken to support sustainable use and conservation of WFPs. This set of actions laid out in the figure below will act to overcome or mitigate against many of the threats and barriers identified.

Figure 2. Proposed best practices for the long-term co-creation of conservation and sustainable use of WFPs help overcome many of the challenges identified.

The proposed set of best practice actions includes: the collection of information (identify the diversity of WFPs that are present in a given environment, information on nutrient composition and contribution to diet, economic importance, and ecological studies to determine sustainable offtake); (ii) prioritize the species with greatest potential to fill nutrition gaps, greatest need in terms of conservation, greatest cultural importance; (iii) protect species that are vulnerable through ex situ conservation; (iv) promote the use and management of WFPs in natural environments (in situ) (including sustainable management and collection guidelines where needed); (v) develop domestication programs where necessary and possible to avoid overexploitation in the wild; (vi) build local capacity to improve storage, processing, value chains, and markets (and all related technology and infrastructure); (vii) integrate WFP into programming and education and other youth outreach so as to raise awareness; (viii) develop and strengthen policies that support the conservation and sustainable use of WFPs; and (ix) and build donor commitment to funding efforts to support sustainable use and conservation of WFPs.

Each community and each WFP are unique, and will require a different set of actions, possibly occurring in a different order. Successful implementation of the set of best practice actions best suited to any given context will require working in a coordinated fashion across disciplines and sectors at the local, regional, and international level, and is largely dependent on the close and active participation of the national and local stakeholders. Due to the limits of time-bound projects (e.g., capacity, resources), it is rare for a single project or intervention to cover all elements or actions needed for a comprehensive and integrated approach. Below we present examples of best practice actions that we believe have successfully helped to further the conservation and sustainable use of WFPs.

6. Conclusions

While WFPs contribute to the diets and livelihoods of millions of people worldwide at the local level, there is still much that we do not yet fully understand about them and thus their role is not fully appreciated. This makes it a challenge when it comes to decisions and actions that might support more effective national and international conservation, sustainable management, and useful strategies for WFPs. While there are an increasing number of publications outlining the importance of WFPs, usually at a local level, there is largely a scarcity of data and information at a national level, and conservation assessments are still limited. This fails to convey the full contribution that WFPs make to food security and nutrition and the overall importance of these biological resources to national economies in many parts of the world. Furthermore, while we increasingly learn more about some of the threats which impact WFPs, we still know so little about their biology and ecology as well as the dynamics of their use and how climate change is impacting them now and in the future. The integrated conservation approach described in this paper is intended to guide stakeholders in creating plans and strategies to ensure that WFPs are used sustainably and are conserved for generations to come.

The contribution of WFPs to food security, nutrition, and livelihoods is significant. With increased development attention and research investments, including a more effective enabling policy environment, the role of WFPs could be strengthened in the future.

A greater understanding and appreciation, especially by decision-makers, of the nutritional value of WFPs and their contribution to food security and nutrition could see the enhanced inclusion of WFPs in important national nutrition policy instruments such as dietary guidelines, development plans, or in nutrition education and school curricula. Greater use should also go hand in hand with increased research and investments targeting existing biological and ecological knowledge gaps on WFPs, such as plant demographic studies to calculate sustainable harvest levels in the wild or studies on seed biology and ecology to ensure they are adequately conserved ex situ. If WFPs were provided with greater policy recognition and support, especially through policy incentives and the development of innovative market-based demand approaches (with clear benefits arising to custodians), it would help create longer-term economic viability. This, in turn, could help greatly in better linking the conservation of WFPs and their sustainable traditional management and use, something which is currently missing in most national Plant Genetic Resources conservation strategies and action plans.

References

1. Zohary, D.; Hopf, M.; Weiss, E. Domestication of Plants in the Old World. The Origin and Spread of Domesticated Plants in South-West Asia, Europe, and the Mediterranean Basin, 4th ed.; Oxford University Press: New York, NY, USA, 2012.
2. Sowunmi, M.A. The beginnings of agriculture in West Africa: Botanical evidence. Curr. Anthropol. 1985, 26, 127–129.
3. Johnson, A.; Behrens, C.A. Nutritional criteria in machiguenga food production decisions: A linear-programming analysis. Hum. Ecol. 1982, 10, 167–189.
4. Heywood, V.H. Use and Potential of Wild Plants in Farm Households; FAO Farm System Management Series; FAO: Rome, Italy, 1999; Volume 15.
5. Bharucha, Z.; Pretty, J. The roles and values of wild foods in agricultural systems. Philos. Trans. R. Soc. B Biol. Sci. 2010, 365, 2913–2926.
6. Casas, A.; Otero-Arnaiz, A.; Perez-Negron, E.; Valiente-Banuet, A. In situ management and domestication of plants in Mesoamerica. Ann. Bot. 2007, 100, 1101–1115.
7. Cruz-Garcia, G.S. Management and motivations to manage “wild” food plants. A case study in a mestizo village in the amazon deforestation frontier. Front. Ecol. Evol. 2017, 5, 127.
8. Heywood, V.H. Overview of Agricultural Biodiversity and Its Contribution to Nutrition and Health. In Diversifying Food and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health; Fanzo, J., Hunter, D., Borelli, T., Mattei, F., Eds.; Routledge: London, UK, 2013; pp. 35–67.

9. Asprilla-Perea, J.; Díaz-Puente, J.M. Importance of wild foods to household food security in tropical forest areas. Food Secur. 2019, 11, 15–22.
10. Bioversity International. Mainstreaming Agrobiodiversity in Sustainable Food Systems: Scientific Foundations for an Agrobiodiversity Index, 1st ed.; Bioversity International: Rome, Italy, 2017.
11. Broegaard, R.B.; Rasmussen, L.V.; Dawson, N.; Mertz, O.; Vongvisouk, T.; Grogan, K. Wild food collection and nutrition under commercial agriculture expansion in agriculture-forest landscapes. For. Policy Econ. 2017.
12. Rowland, D.; Ickowitz, A.; Powell, B.; Nasi, R.; Sunderland, T. Forest foods and healthy diets: Quantifying the contributions. Environ. Conserv. 2017, 44, 102–114.
13. Ickowitz, A.; Powell, B.; Rowland, D.; Jones, A.; Sunderland, T. Agricultural intensification, dietary diversity, and markets in the global food security narrative. Glob. Food Sec. 2019, 20, 9–16.
14. Carvalho, A.M.; Barata, A.M. The Consumption of Wild Edible Plants. In Wild Plants, Mushrooms and Nuts; John Wiley & Sons, Ltd.: Chichester, UK, 2016; pp. 159–198.
15. Ojelel, S.; Mucunguzi, P.; Katuura, E.; Kakudidi, E.K.; Namaganda, M.; Kalema, J. Wild edible plants used by communities in and around selected forest reserves of Teso-Karamoja Region, Uganda. J. Ethnobiol. Ethnomed. 2019, 15, 3.
16. Kuhnlein, H.V.; Erasmus, B.; Spigelski, D. Indigenous Peoples' Food Systems: The Many Dimensions of Culture, Diversity and Environment for Nutrition and Health; Food and Agriculture Organization of the United Nations: Rome, Italy, 2009.
17. Kuhnlein, H.V. Holding on to Agrobiodiversity: Human Nutrition and Health of Indigenous Peoples. In Routledge Handbook of Agricultural Biodiversity; Hunter, D., Guarino, L., Spillane, C., McKeown, P.C., Eds.; Routledge: London, UK, 2017; p. 692.
18. United Nations. State of the World's Indigenous Peoples; United Nations: New York, NY, USA, 2009.
19. Angelsen, A. Policies for reduced deforestation and their impact on agricultural production. Proc. Natl. Acad. Sci. USA 2010, 107, 19639–19644.
20. Powell, B.; Thilsted, S.H.; Ickowitz, A.; Termote, C.; Sunderland, T.; Herforth, A. Improving diets with wild and cultivated biodiversity from across the landscape. Food Secur. 2015, 7, 535–554.
21. Aryal, K.P.; Poudel, S.; Chaudhary, R.P.; Chettri, N.; Chaudhary, P.; Ning, W.; Kotru, R. Diversity and use of wild and non-cultivated edible plants in the western Himalaya. J. Ethnobiol. Ethnomed. 2018, 14, 10.
22. Boedecker, J.; Termote, C.; Assogbadjo, A.E.; Van Damme, P.; Lachat, C. Dietary contribution of wild edible plants to women's diets in the buffer zone around the Lama forest, Benin—An underutilized potential. Food Secur. 2014, 6, 833–849.
23. Ju, Y.; Zhuo, J.; Liu, B.; Long, C. Eating from the wild: Diversity of wild edible plants used by Tibetans in Shangri-La Region, Yunnan, China. J. Ethnobiol. Ethnomed. 2013, 9, 28.
24. Shumsky, S.A.; Hickey, G.M.; Pelletier, B.; Johns, T. Understanding the contribution of wild edible plants to rural social-ecological resilience in Semi-Arid Kenya. Ecol. Soc. 2014, 19, art34.
25. Smith, E.; Ahmed, S.; Dupuis, V.; Running Crane, M.; Eggers, M.; Pierre, M.; Flagg, K.; Byker Shanks, C. Contribution of wild foods to diet, food security, and cultural values amidst climate change. J. Agric. Food Syst. Community Dev. 2019, 1–24.
26. Fernández-Ruiz, V.; Morales, P.; Ruiz-Rodríguez, B.M.; Isasa, E.T. Nutrients and Bioactive Compounds in Wild Fruits Through Different Continents. In Wild Plants, Mushrooms and Nuts; John Wiley & Sons, Ltd.: Chichester, UK, 2016; pp. 263–314.
27. Hunter, D.; Borelli, T.; Beltrame, D.M.O.; Oliveira, C.N.S.; Coradin, L.; Wasike, V.W.; Wasilwa, L.; Mwai, J.; Manjella, A.; Samarasinghe, G.W.L.; et al. The potential of neglected and underutilized species for improving diets and nutrition. Planta 2019, 250, 709–729.
28. Morales, P.; Herrera, P.G.; González, M.C.M.; Hurtado, M.C.; de Cortes Sánchez Mata, M. Wild Greens As Source of Nutritive and Bioactive Compounds Over the World. In Wild Plants, Mushrooms and Nuts; John Wiley & Sons, Ltd.: Chichester, UK, 2016; pp. 199–261.
29. Kinnunen, P.; Guillaume, J.H.A.; Taka, M.; D'Odorico, P.; Siebert, S.; Puma, M.J.; Jalava, M.; Kummu, M. Local food crop production can fulfil demand for less than one-third of the population. Nat. Food 2020, 1, 229–237.
30. Padulosi, S.; Mal, B.; King, O.; Gotor, E. Minor millets as a central element for sustainably enhanced incomes, empowerment, and nutrition in rural India. Sustainability 2015, 7, 8904–8933.

31. Shackleton, S.; Paumgarten, F.; Kassa, H.; Husselman, M.; Zida, M. Opportunities for enhancing poor women's socioeconomic empowerment in the value chains of three African Non-Timber Forest Products (NTFPs). Int. For. Rev. 2011, 13, 136–151.

32. Torero, M. Without food, there can be no exit from the pandemic. Nature 2020, 580, 588–589.

33. HLPE. Food Security and Nutrition: Building a Global Narrative towards 2030; HLPE: Rome, Italy, 2020.

34. Béné, C. Resilience of local food systems and links to food security—A review of some important concepts in the context of COVID-19 and other shocks. Food Secur. 2020.

35. Fernandes, N. Economic effects of coronavirus outbreak (COVID-19) on the world economy. SSRN Electron. J. 2020.

36. United Nations. Policy Brief: The Impact of COVID-19 on Food Security and Nutrition; United Nations: New York, NY, USA, 2020; p. 23.

37. Vandebroek, I.; Pieroni, A.; Stepp, J.R.; Hanazaki, N.; Ladio, A.; Alves, R.R.N.; Picking, D.; Delgoda, R.; Maroyi, A.; van Andel, T.; et al. Reshaping the future of ethnobiology research after the COVID-19 pandemic. Nat. Plants 2020, 6, 723–730.

38. Cappelli, A.; Cini, E. Will the COVID-19 pandemic make us reconsider the relevance of short food supply chains and local productions? Trends Food Sci. Technol. 2020, 99, 566–567.

39. IPES-Food. COVID-19 and the Crisis in Food Systems: Symptoms, Causes, and Potential Solutions; IPES-Food: Brussels, Belgium, 2020.

40. Poppick, L. The Effects of COVID-19 Will Ripple through Food Systems. Available online: https://www.scientificamerican.com/article/the-effects-of-covid-19-will-ripple-through-food-systems/ (accessed on 13 July 2020).

41. Mururia, D.; Mwale, A. Demand for Indigenous Vegetables Soar as Residents Grapple with COVID-19 Economic Shocks. Available online: https://www.kenyanews.go.ke/demand-for-indigenous-vegetables-soar-as-residents-grapple-with-covid-19-economic-shocks/ (accessed on 13 July 2020).

42. Giuliano, G. Coronavirus: From Wild Tobacco New Perspectives in the Treatment of COVID-19. Available online: https://www.enea.it/en/news-enea/news/coronavirus-from-wild-tobacco-new-perspectives-in-the-treatment-of-covid-19 (accessed on 13 July 2020).

43. Timoshyna, A.; Ling, X.; Zhang, K. COVID-19—The Role of Wild Plants in Health Treatment and Why Sustainability of Their Trade Matters. Available online: https://www.traffic.org/news/covid-19-the-role-of-wild-plants-in-health-treatment/ (accessed on 13 July 2020).

44. Ulian, T.; Diazgranados, M.; Pironon, S.; Padulosi, S.; Davies, L.; Howes, M.-J.; Borrell, J.; Ondo, I.; Perez Escobar, O.A.; Sharrock, S.; et al. Unlocking plant and fungal resources to support food security and promote sustainable agriculture. Plants People Planet 2020.

45. Díaz, S.; Settele, J.; Eduardo, B.; Ngo, H.T.; Guèze, M.; Agard, J.; Arneth, A.; Balvanera, P.; Brauman, K.; Butchart, S.; et al. The Global Assessment Report on Report on Biodiversity and Ecosystem Services. Summary for Policymakers; IPBES: Bonn, Germany, 2019.

46. Masson-Delmotte, V.; Zhai, P.; Pörtner, H.-O.; Roberts, D.; Skea, J.; Calvo, E.; Priyadarshi, B.; Shukla, R.; Ferrat, M.; Haughey, E.; et al. Climate Change and Land: IPCC Report; IPCC: Geneva, Switzerland, 2019.

47. FAO. The State of the World's Biodiversity for Food and Agriculture; FAO: Rome, Italy, 2019.

48. Royal Botanic Gardens, Kew. State of the World's Plants; Royal Botanic Gardens, Kew: London, UK, 2016.

49. Sunderland, T.C.H. Food Security: Why Is Biodiversity Important? Int. For. Rev. 2011, 13, 265–274.

50. Kew. Plants under Pressure—A Global Assessment; Royal Botanic Gardens: Kew, UK; Natural History Museum: London, UK, 2016.

51. Khoury, C.K.; Amariles, D.; Soto, J.S.; Diaz, M.V.; Sotelo, S.; Sosa, C.C.; Ramírez-Villegas, J.; Achicanoy, H.A.; Velásquez-Tibatá, J.; Guarino, L.; et al. Comprehensiveness of conservation of useful wild plants: An operational indicator for biodiversity and sustainable development targets. Ecol. Indic. 2019, 98, 420–429.

52. Jarvis, A.; Upadhyaya, H.; Gowda, C.; Aggarwal, P.K.; Fugisaka, S.; Anderson, B. Climate Change and Its Effect on Conservation and Use of Plant Genetic Resources for Food and Agriculture and Associated Biodiversity for Food Security; Thematic Study SoW Report PGRFA; FAO: Rome Italy, 2008; p. 26.

53. Tata Ngome, P.I.; Shackleton, C.; Degrande, A.; Tieguhong, J.C. Addressing constraints in promoting wild edible plants' utilization in household nutrition: Case of the Congo basin forest area. Agric. Food Secur. 2017, 6, 1–10.

54. Jaenicke, H.; Höschle-Zeledon, I. (Eds.) Strategic Framework for Underutilized Plant Species Research and Development, with Special Reference to Asia and the Pacific, and to Sub-Saharan Africa; International Centre for Underutilised Crops, Colombo, Sri Lanka and Global Facilitation Unit for Underutilized Species: Rome, Italy, 2006.
55. Powell, B.; Ouarghidi, A.; Johns, T.; Ibn Tattou, M.; Eyzaguirre, P. Wild leafy vegetable use and knowledge across multiple sites in Morocco: A case study for transmission of local knowledge? J. Ethnobiol. Ethnomed. 2014, 10.
56. Pawera, L.; Khomsan, A.; Zuhud, E.A.M.; Hunter, D.; Ickowitz, A.; Polesny, Z. Wild food plants and trends in their use: From knowledge and perceptions to drivers of change in West Sumatra, Indonesia. Foods 2020, 9, 1240.
57. Hawkes, C. Uneven dietary development: Linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. Glob. Health 2006, 2.
58. Biodiversity, Food and Nutrition. A New Agenda for Sustainable Food Systems, 1st ed.; Hunter, D., Borelli, T., Gee, E., Eds.; Routledge: Oxford, UK, 2020.
59. Fanzo, J.; Davis, C. Can diets be healthy, sustainable, and equitable? Curr. Obes. Rep. 2019, 8, 495–503.
60. Li, D.-Z.; Pritchard, H.W. The science and economics of ex situ plant conservation. Trends Plant Sci. 2009, 14, 614–621.
61. Commission on Genetic Resources for Food and Agriculture—FAO. The Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture; Food and Agricultural Organization of the United Nations: Rome, Italy, 2012.
62. FAO. Voluntary Guidelines for the Conservation and Sustainable Use of Crop Wild Relatives and Wild Food Plants; Food and Agriculture Organization of the United Nations: Rome, Italy, 2017.
63. Vernooy, R.; Bessette, G.; Otieno, G. (Eds.) Resilient Seed Systems: Handbook, 2nd ed.; Bioversity International: Rome, Italy, 2019.