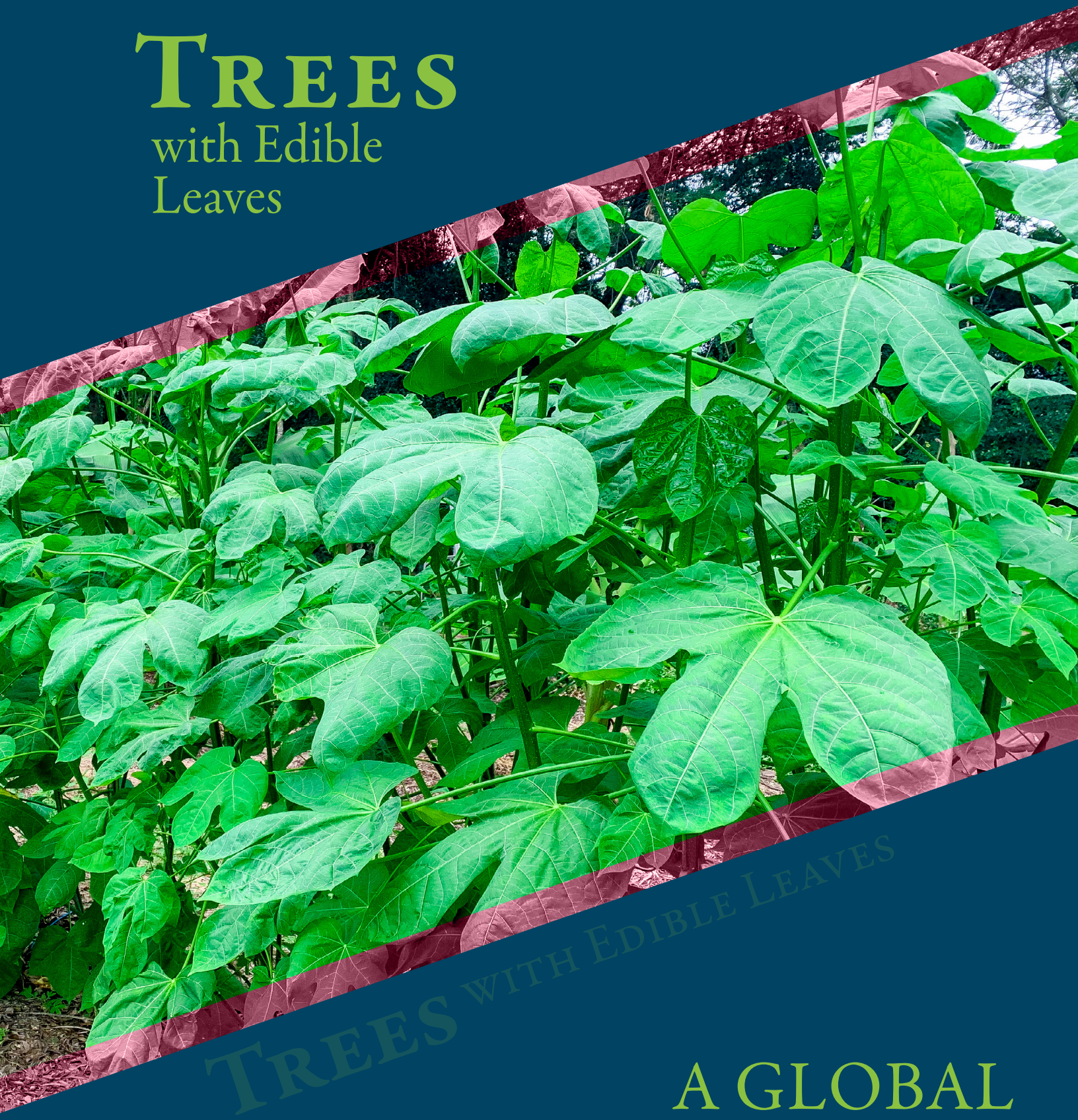
Perennial Agriculture Institute

Trees with Edible Leaves



Trees with Edible Leaves

A Global Manual

Perennial Agriculture Institute

www.perennialagriculture.institute

"To mitigate climate change by accelerating the adoption of agroforestry and perennial crops"

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with contributions from Erica Klopf

2022

Contents

The cover image is a hedgerow of "jumbo-leaf" chaya (*Cnidoscolus aconitifolius).* Courtesy of Josh Jamison of Cody Cove Farm and Nursery.

INTRODUCTION

ABOUT *Trees with Edible Leaves*

In 2020, the Perennial Agriculture Institute (PAI) published "Perennial vegetables: A neglected resource for biodiversity, carbon sequestration, and nutrition" in the peer-reviewed journal *PLOS One.* We provided an inventory of more than 600 cultivated species around the world, estimated their carbon sequestration potential, and investigated their capacity to address the nutrient deficiencies that impact more than two billion people in both the Global North and the Global South. One group of cultivated species clearly stood out for outstanding nutrition: trees with edible leaves. We wrote *Trees with Edible Leaves* to highlight this extraordinary, and largely overlooked, group of plants.

This publication profiles one hundred and two species of trees, shrubs, and cacti that are grown for their edible leaves and shoots. To our knowledge, this information has never before been brought together in one place. (Hundreds of non-cultivated species are also worthy of attention and perhaps PAI will undertake such an inventory in a future edition.)

Chapter One provides an overview of these tree vegetables. Where do they originate? What impact could they have on nutrient deficiencies? What climate change mitigation and adaptation benefits do they offer? And what other benefits do they offer?

Chapter Two provides an overview of growing these species. Despite their great diversity and disparate origins, virtually all are grown using the same basic techniques. Here we describe those practices and how they are integrated into complex agroforestry systems. Basic information is also provided on propagation and care of trees with edible leaves.

The remaining chapters profile cultivated species. Each profile provides a description, details of climate and soil suitability, nutrition, propagation, and growing systems. Because this is a global guide, wherever possible we provide names for all species in the world's twenty most widely-spoken languages: English, Mandarin Chinese, Hindi, Spanish, French, Arabic, Bengali, Russian, Portuguese, Indonesian, Urdu, German, Japanese, Swahili, Marathi, Telugu, West Punjabi, Wú Chinese, Tamil, and Turkish. Names are also provided in the languages of the region where the crop was originally taken into cultivation. Each crop is labeled with English name and one name from its homeland.

Chapter Three profiles species for cold climates, including both temperate and boreal regions. Chapter Four focuses on species for tropical and subtropical drylands. And Chapter Five describes species for the humid tropics and subtropics.

Appendix A provides detailed nutritional information for fifty-one species (data for the remainder were unavailable). Appendix B includes our recommended resources for further learning.

Trees with Edible Leaves will soon be available in Spanish. Please contact us if you are interested in translating it into other languages.

This project was funded in large part by Trees for Climate Health, an initiative of Jonas Philanthropies. Writing was also supported by Eric Toensmeier's Patreon patrons. Thanks to the support of these funders this publication is available as a free download for all. Thanks as well to project fiscal sponsor Interlace Commons.

Thank you to everyone who reviewed the writing or answered interview questions. These include Rick Burnette of Cultivate Abundance, Josh Jamison of Cody Cove Farm and Nursery, Maarten van Zonneveld and Soenghoe Jang of the World Vegetable Centre, and Ricardo Romero of Las Cañadas. We also apprciate the marvelous online resource of creative commons images, which made this manual come to life.

CHAPTER ONE

Trees with Edible Leaves

In a time when more trees are desperately needed to address climate change, how marvelous to learn that there are many species of trees grown for their edible leaves! In some parts of the world, this is an unbroken tradition that goes back for thousands of years. For many people however, trees with edible leaves sound fantastical, like something from a children's story. It seems likely that most people in the world have never eaten a tree leaf. These species have tremendous potential to provide the nutrients that billions of people are missing in their diets, to help perennialize agriculture and draw down excess carbon from the atmosphere, to diversify our farms and gardens, to improve the health of our soils, and much more.

For purposes of this publication, trees with edible leaves are defined as woody plants growing at least two meters tall if unpruned, including trees, shrubs, and cacti with leaves eaten as a vegetable, rather than as a culinary herb or spice. In addition to the leaves, shoots and tender young stems are eaten in many cases. Cactus pads (cladodes) are also included. A handful of these species are more properly seen as "semi-woody", such as aibika and cassava. Hundreds of species meet these criteria.

Figure 1.1. *Moringa stenopetala* was domesticated by Ethiopian and Kenyan farmers for its highly nutritious leaves. Image courtesy Trees for a Future.

Because the incredible diversity of such species can be overwhelming, in this publication we decided to focus on the species that are *cultivated* for their edible leaves. They are grown in home gardens, produced for local markets, and a few are even traded globally. We profile those for which we found documentation of cultivation, though we surely missed a number of them. Many of these are outstanding vegetables in their own right. Perhaps a future publication will inventory *wild* tree vegetable species, many of which are popular enough to be sold in markets.

The flavor and texture of these leaves varies widely, as much or more than common annual vegetables. The flavor of some resembles familiar vegetables like lettuce, celery, kale, or mustard. Some are spicy, salty, bland, or bitter. A few taste like chicken soup or root beer. In the kitchen they are used in every way imaginable, with most requiring cooking but many that can be eaten raw (assume they should be cooked unless otherwise noted). A few are poisonous unless thoroughly cooked, and one or two have additional toxicity. Our criteria here is to include species which farmers and gardeners grow for their leaves, not to judge them on flavor, texture, or even toxicity. Trees with edible leaves can be fermented, dried, processed, and stored in all the ways that common annual vegetables are.

The idea of growing trees for their edible leaves seems to have come about independently in many places around the world, many times over. Box 1.1 introduces these hotspots of cultivation. What's quite remarkable is that the same basic techniques are used, wherever these species are grown. These strikingly universal approaches to cultivation are discussed in detail in Chapter 2.

The Perennial Agriculture Institute's 2020 paper "Perennial vegetables: A neglected resource for biodiversity, carbon sequestration, and nutrition" provides an inventory of more than 600 cultivated species of perennial vegetables from

around the world. In our analysis, trees with edible leaves stood out as a class for their remarkable nutrition and carbon sequestration potential. This publication is a deeper dive into this extraordinary group of plants.

How widely are trees with edible leaves grown? While a great diversity of species are grown in many places, it seems that their global footprint is rather small. Moringa, which has become very popular in recent years, is reportedly grown on 500,000 hectares globally. Nopale cacti are produced on an estimated 20,000 ha. About 18,000 hectares of tea grown in Myanmar is used as a fermented vegetable in the form of *laphet.* Cassava is very widely grown, but the Food and Agriculture Organization (FAO) calculates that only about 9,000 hectares are in dedicated leaf production in any given year. For comparison, combined global production of brassicas, lettuce, and spinach is around 4.6 million hectares. It may also be that the area in trees with edible leaves is considerably higher as very little data is available.

BIODIVERSITY

How many of the world's trees have edible leaves? No global inventory has been conducted to our knowledge, but there are surely many hundreds or thousands. A forthcoming Perennial Agriculture Institute study of Mexican native perennial vegetables found eighty-seven trees and shrubs with edible leaves, of which nine were cultivated specifically for that purpose. That's nine wild species for every cultivated one, and suggests that the species profiled in the manual you are reading may be just the beginning. Indeed, while researching this book, we identified a great many species which, while not necessarily grown for food, are important wild foods. The leaves of many of these wild trees are often sold in local markets. Biodiversity is also important in food gardens and farms because many pests and diseases are specific to a particular botanical family of crops. Because trees with edible leaves come from many botanical families not already grown for food, they are resistant to the insects, fungi, and bacteria that attack our food crops.

Of the one hundred and two species we identified, some botanical families stood out. The legumes (Fabaceae) have fifteen species in eight genera, the mulberry family (Moraceae) have twelve species in four genera, and the aralias (Araliaceae) have eleven species in five genera. Other significant families are the Malvaceae, Cactaceae, and Euphorbiaceae with six species each, and the Rubiaceae and Lamiaceae, each with four species. There were also standout genera. *Ficus* was the most diverse, with seven cultivated species, followed by *Opuntia* with five, and *Eleutheroccus* and *Polyscias* with four each. *Erythrina, Pterocarpus, Senegalia,* and *Tilia* all had three species.

There are many fantastic species not included in this guide as we were unable to verify that they are deliberately grown as a vegetable. That should not keep you from growing them! We also anticipate learning that other species are cultivated after releasing this publication, and hope to release an updated edition in the years to come.

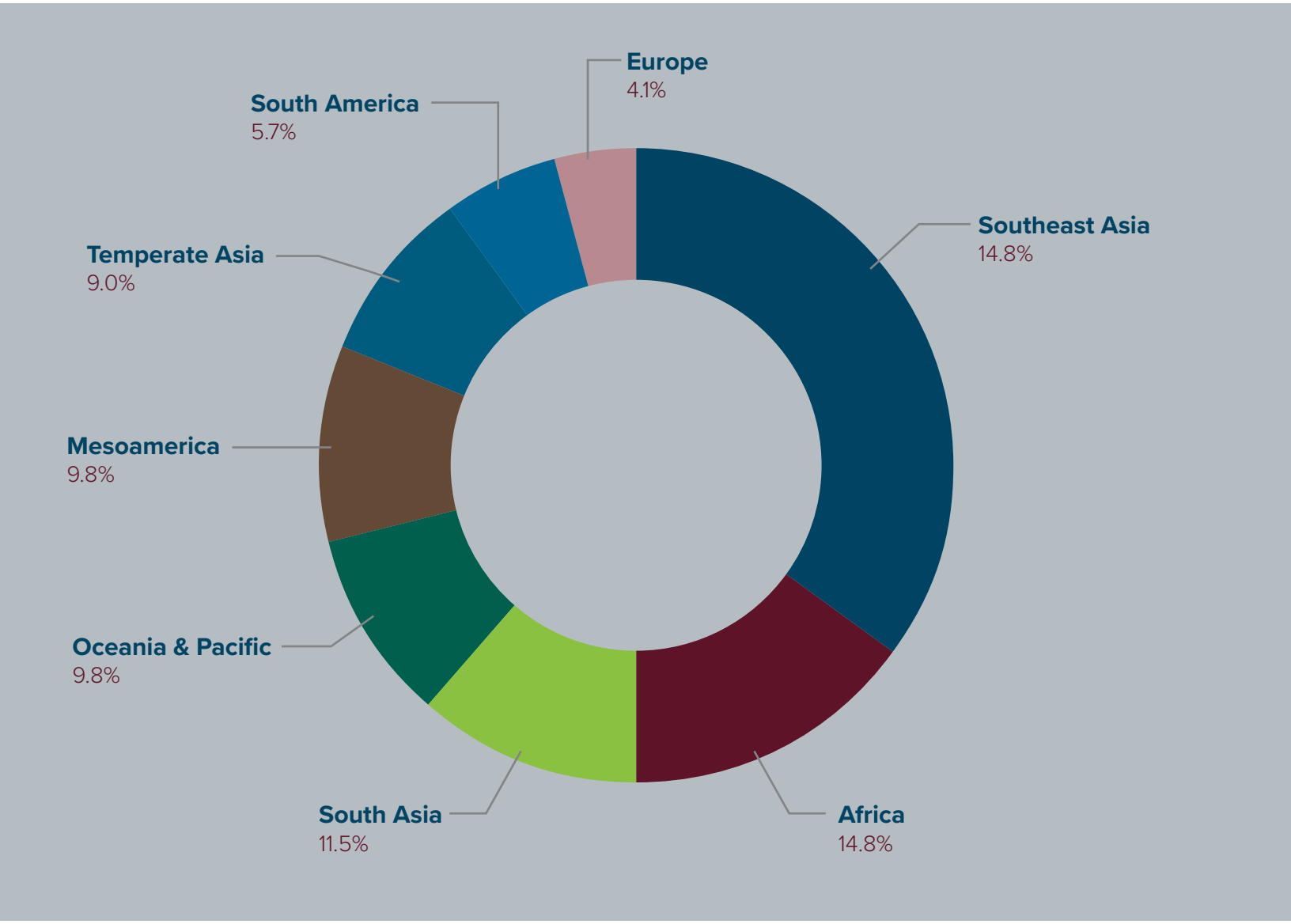
Are the cultivated species the best tasting, most nutritious, or most productive? Not necessarily. In many cases these species are not brought into cultivation until wild populations are reduced by deforestation. For example this trend is behind the relatively recent cultivation of *Stahphylea* in China.

It's generally best to begin with species native to your own region, and for some parts of the world there are many such trees to choose from. Other regions have no native cultivated species, and will need to decide to grow something new or bring a few promising native species into cultivation. A handful of the species featured in this book are listed in the Global Invasive Species Database, and if so it is noted in their profile. All of them are of course native somewhere, often to a very large area.

BOX 1.1: WHERE WERE TREES WITH EDIBLE LEAVES BROUGHT INTO CULTIVATION?

Farmers and gardeners of Southeast Asia have brought, by far, the most trees with edible leaves into cultivation: a total of forty-three species. A number of regions cultivate between ten and fifteen species, including Africa, South Asia, Mesoamerica, Oceania and Pacific Islands, and temperate Asia. This may, to some degree, reflect an absence of documentation in regions like sub-Saharan Africa and Amazonia. Figure 1.2 shows the breakdown by region.

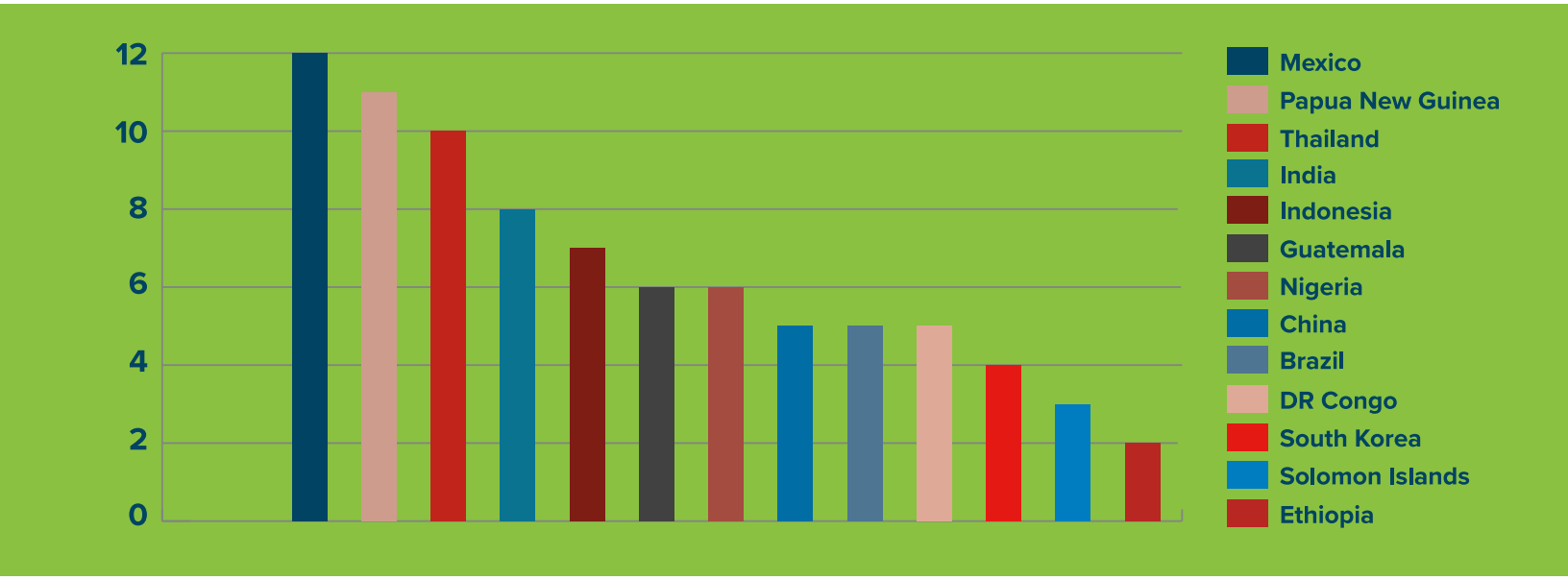
Figure 1.2: Region of Cultivation Origin



Looking at specific countries of origin, Mexico, Papua New Guinea, and Thailand stand out with ten or more species each. Countries with five or more species are Brazil, China, Democratic Republic of the Congo, Guatemala, India, Indonesia, and Nigeria. Additional countries with two or more species are Ethiopia, South Korea, and Solomon Islands. However, much of the available data is only specific to the regional level, eg. “Southeast Asia” or “tropical Africa,” which means that Figure 1.3 should be viewed only as a preliminary effort in understanding of countries of origin.

Note that while a species may have been brought into cultivation in a particular country or region, its native range may be much wider. For example, while *Eleutherococcus senticosus* is grown as a vegetable in Japan, it is actually native across much of temperate Asia and Siberia.

Figure 1.3: Country of Cultivation Origin



CLIMATE CHANGE MITIGATION AND ADAPTATION

The perennialization of agriculture is an important tool for removing excess carbon dioxide from the atmosphere and storing it in soil organic matter and perennial biomass. This process is called carbon sequestration. Agricultural systems that reduce or eliminate tillage tend to increase soil carbon; most agricultural systems that involve growing trees with edible leaves are no-till. Adding woody perennials to annual cropping systems ("silvoarable" agroforestry) also increases carbon sequestration. Indeed, trees with edible leaves can play an important role in such systems. The coppicing, pollarding, and lopping approaches that are used in production of trees with edible leaves all sequester carbon—and the larger the tree trunk, the more carbon it holds.

Generally, these silvoarable agroforestry systems sequester less carbon than orchards, but more than the best annual cropping systems. For example, annually coppiced beds are similar to fodder banks, which sequester 0.1-0.5 tons of carbon per hectare each year (tC/ha/yr). Pollarded systems are more comparable to short rotation coppice, with a rate of 1.2 t/ha/yr. When grown in complex multistrata agroforestry systems with multiple layers of trees, rates range from 1-7 t/ha/yr. By comparison, improved annual vegetable production practices like cover cropping with reduced tillage sequester an average of 0.3 tC/ha/yr. Increasing production of trees with edible leaves can be part of a larger program for agricultural climate change mitigation.

While no individual gardener or farmer can mitigate climate change on their own, all must adapt to it. Challenges include higher temperatures, more erratic weather, longer dry periods, increasingly intense rainfall, flooding, and more.

Agroforestry and perennial crops are powerful adaptation tools for several reasons. For example, increased rainfall intensity means more erosion. Perennial crops in no-till systems, like trees with edible leaves, are an excellent tool for erosion control. Strips of perennials planted along or near the contour on slopes of cropland increase organic matter and improve the infiltration of rainfall. This soil water storage helps reduce vulnerability to drought and also catches and slowly releases water, reducing vulnerability to flooding as well. The deep roots of tree crops, including tree vegetables, make them much more resilient in the face of droughts. The leaves are often available well into the dry season in the subtropics.

Additionally, trees (even hedges and low-growing trees) moderate temperatures. This improves working conditions for growers; creates pleasant green space in courtyards and rooftop gardens; and offers a temperature microclimate for heat sensitive crops such as lettuce and spinach.

NUTRITION

One of the most important benefits of trees with edible leaves is nutrition. All vegetables are valuable, given that humanity needs to triple vegetable production just to meet current global dietary needs. More than two billion people are impacted by nutrient deficiencies tied to low vegetable consumption. Deficiencies fall into two broad classes. “Traditional malnutrition,” which is primarily an issue in the Global South, is the lack of iron, zinc, folate, and Vitamin A. Impacts include anemia, congenital disorders, childhood blindness, maternal mortality, and vulnerability to infections. Meanwhile in the Global North, and in urban areas around the world, “industrial diet deficiencies,” resulting from low intake of fiber, calcium, magnesium, and antioxidants like Vitamins A, C, and E, play a role in heart disease, osteoporosis, diabetes, high blood pressure, and more.

Figure 1.4: *Toona sinensis*, among the world’s most nutritious vegetables. Image Eric Toensmeier, CC 3.0.

PAI’s 2020 paper “Perennial Vegetables: A Neglected Resource for Biodiversity, Carbon Sequestration, and Nutrition” combed the literature to find average values of the key nutrients needed to address these deficiencies, in both annual and perennial vegetables. A group of widely grown and marketed “reference vegetables” was used for comparison. Trees with edible leaves emerged as the class of vegetables with the highest levels of these key nutrients.

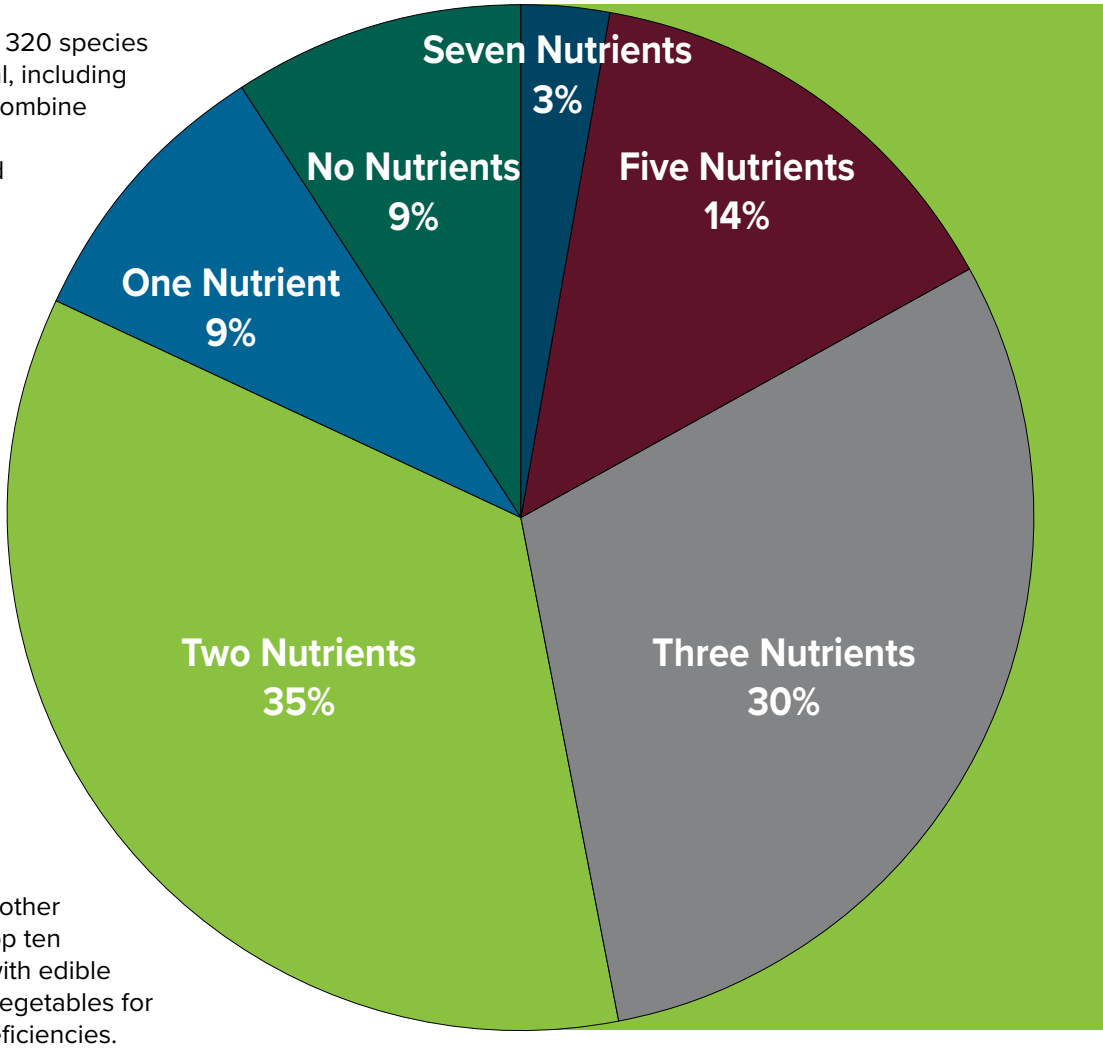
For this book, PAI collected much more data on trees with edible leaves. More data were found on the thirty-one trees with edible leaves covered in the initial paper, and data on twenty additional species were also gathered. Full data on the nutrient composition of the cultivated species profiled in this book are presented in Appendix A.

What we found confirmed and extended the status of tree leaves as a class that offers an exceptional source of nutrition, though of course not every tree with edible leaves is notable in this regard.

SUPERABUNDANT NUTRIENT SPECIES

Superabundant nutrient levels are those that are above the highest levels found in common "reference vegetables" available globally in markets. Twenty-two reference vegetables are used, including crops like tomato (*Solanum lycopersicon*), cabbage (*Brassica oleracea*), cucumber (*Cucumis sativus*), onion (*Allium cepa*) and green beans (*Phaseolus vulgaris*). Our paper showed that trees with edible leaves were the class of vegetables most likely to be superabundant in one or more key nutrients. Our larger group of cultivated trees with edible leaves shows a similar trend. In fact, of the cultivated species in this book, only four of the fifty-one were *not* superabundant in at least one nutrient. One species (mulberry) is superabundant in seven. It is worth noting that most species were missing data on one or more nutrients, so levels of superabundance could actually be even higher. Figure 1.5 shows the level of superabundance in the fifty-one species for which data were available.

Figure 1.5: Level of nutrient superabundance in cultivated edible tree leaf species



PAI's 2020 paper provided data on 320 species of vegetables, annual and perennial, including trees with edible leaves. Here we combine this with our updated data on trees with edible leaves to create revised listings of the species with the top ten highest content of the key nutrients needed to address the nutritional deficiencies described above. Trees with edible leaves represent between two and seven of the top ten of all the world's cultivated vegetables (woody, perennial, and annual) for each of these vitally needed nutrients. It especially notable that some species are on the top ten list for as many as four nutrients. That means that of hundreds of species of cultivated vegetables that have been tested, both *Morus alba* and *Atriplex halimus* are among the ten most nutritious for *four* of the nine key nutrients needed to address deficiencies that impact several billion people. And several other species show up on two or three top ten lists. Tables 1.1 and 1.2 show trees with edible leaves ranked in the top ten of all vegetables for the nutrients needed to address deficiencies.

Table 1.1: Trees with Edible Leaves with Nutrient Content in the Top Ten Highest for All Cultivated Vegetables, for Traditional Malnutrition

Iron	Zinc	Vitamin A	Folate
Atriplex halimus, Morus alba, Vitex doniana	*Atriplex halimus, Pterocarpus mildbraedii, Senegalia rugosa*	*Cnidoscolus aconitifolius, Morinda citrifolia, Senna obtusifolia, Toona sinensis*	*Eleutherococcus senticosus, Morus alba*

Table 1.2: Trees with Edible Leaves with Nutrient Content in the Top Ten Highest for All Cultivated Vegetables, for Industrial Diet Deficiencies

Fiber	Calcium	Magnesium	Vitamin A	Vitamin C	Vitamin E
Azidirachta indica, Balanites aegyptiaca, Eleutherococcus senticosus, E.trifoliatus, Moringa stenopetala	*Atriplex halimus, Ficus copiosa, Moringa stenopetala, Morus alba, Sesbania grandiflora*	*Atriplex halimus, Ceiba pentandra, Lycium chinense, Pereskia aculeata, Pisonia umbellifera, Pseuderanthemum carruthersii, Pterocarpus mildbraedii*	*Cnidoscolus aconitifolius, Morinda citrifolia, Senna obtusifolia, Toona sinensis*	*Cnidoscolus aconitifolius, Manihot esculenta, Moringa oleifera, Morus alba*	*Balanites aegyptiaca, Eleutherococcus senticosus, Manihot esculenta, Toona sinensis, Vitex doniana*

MULTI-NUTRIENT SPECIES

Many trees with edible leaves are *multi-nutrient species*, providing high or superabundant levels of multiple key nutrients for traditional malnutrition and/or industrial diet deficiencies. Tables 1.3 and 1.4 list these species, and it is noted in their profiles in Chapters 3-5 as well. It is especially worth noting that quite a few species are present in both tables, including chaya, Siberian ginseng, cassava, noni, moringa, mulberry, sicklepod, and Chinese toon. Such nutritional powerhouses should be widely planted wherever either form of deficiency is present. Trees with edible leaves are disproportionately likely to be multi-nutrient species. Of the multi-nutrient species identified in PAI's 2020 paper, 50% are trees with edible leaves, even though they make up only 12% of the total species for which data were available.

Table 1.3: Multi-Nutrient Species for Traditional Malnutrition

Species	English Name	Iron	Zinc	Vitamin A	Folate
Cnidoscolus aconitifolius	chaya	extremely high		extremely high	
Eleutherococcus senticosus	Siberian ginseng	very high	very high	very high	high
Manihot esculenta	cassava	very high	very high	very high	
Morinda citrifolia	noni	very high	high	extremely high	
Moringa oleifera	moringa*	extremely high	very high	very high	
Morus alba	mulberry	extremely high	very high	high	very high
Senna obtusifolia	sicklepod	extremely high		extremely high	
Toona sinensis	Chinese toon	extremely high	very high	extremely high	

*Moringa leaf alone is not a multi-nutrient species for this category, but it is with the addition of its edible flowers and pods.

Table 1.4: Multi-Nutrient Species for Industrial Diet Deficiencies

Species	English Name	Fiber	Calcium	Magnesium	Vitamin A	Vitamin C	Vitamin E
Atriplex halimus	tree purslane	very high	Extremely high	Extremely high			
Azadirachta indica	neem	extremely high	high		high	high	
Balanites aegyptiaca	balanites	extremely high					extremely high
Cnidoscolus aconitifolius	chaya		very high	very high	extremely high	very high	
Eleutherococcus senticosus	Siberian ginseng	extremely high	high		very high	high	extremely high
E. trifoliatus	three-leaved eleuthero	extremely high	very high		extremely high		
Gnetum gnemon	spinach jointfir	very high		high	high	very high	high
Lycium chinense	edible-leaf goji		high	extremely high	high		extremely high
Manihot esculenta	cassava	high	high		very high	extremely high	extremely high
Morinda citrifolia	noni	high	very high	very high	extremely high		
Moringa oleifera	moringa*	high	very high	very high	very high	very high	high
M. stenopetala	African moringa	extremely high	extremely high				
Morus alba	mulberry	very high	extremely high	very high	high	very high	
Pereskia aculeata	ora pro nobis	extremely high	very high	very high		very high	
Pisonia grandis	lettuce tree	very high	very high	very high			
Sauropus androgynus	katuk				very high	very high	extremely high
Senna obtusifolia	sicklepod		very high		extremely high	very high	
Sesbania grandiflora	vegetable hummingbird	extremely high	extremely high	very high		high	high
Toona sinensis	Chinese toon	high	very high		extremely high	high	extremely high

*Moringa leaf alone is not a multi-nutrient species for this category, but it is with the addition of its edible flowers and pods.

OTHER BENEFITS

Low Labor Requirement

A tremendous advantage of trees with edible leaves is their low labor requirement, especially in systems using manual labor. Years ago we heard from a gardening project for people with HIV in Mozambique. They reported that perennial vegetables like moringa and chaya were very popular because, once established, they required very little work to maintain high yields. They also noted that trees with edible leaves that were pruned to 1-2 meters high did not require any bending over or crouching for harvest or maintenance, which was a big advantage. Coppicing and pollarding also keeps leaves closer to the ground where they can be much more easily harvested than from mature-sized trees. In our own experience these species require very little labor, just a minimum of pruning once or twice a year, and of course harvesting. An exception is areas with highly mechanized vegetable production, which is not yet broadly available for trees with edible leaves except for a few species like moringa and mulberry.

COMPETITIVE YIELDS

Yields of many species are as high or higher than annual leafy greens. Table 1.5 shows yields of selected species as compared with cabbage, lettuce, and spinach. However keep in mind that in some climates more than one crop of these annuals is possible.

Table 1.5 Yields of Selected Trees with Edible Leaves and Annual Leaf Crops

ANNUAL CROPS FOR REFERENCE				
Latin Name	**Common Name**	**Tons per hectare per year fresh weight**	**Kg per square meter per year fresh weight**	**Kg per 100 meter hedge per year fresh weight**
Brassica oleracea	cabbage	10-60	1-6	
Lactuca sativa	lettuce	3-30	0.3-3	
Spinacea oleracea	spinach	10-25	1-2.5	
TREES WITH EDIBLE LEAVES				
Latin Name	**Common Name**	**Tons per hectare per year fresh weight**	**Kg per square meter per year fresh weight**	**Kg per 100 meter hedge per year fresh weight**
Abelmoschus manihot	aibika	15-60	1.5-6	
Cnidoscolus aconitifolius	chaya		38	20-80
Lycium chinense	edible-leaf goji	2-4		
Manihot esculenta	cassava	10-20	15	
Moringa oleifera	moringa	10-52	60	
Morus alba	mulberry	8-52		
Opuntia ficus-indica	nopale cactus	90		
Sauropus androgynus	katuk		30	
Vernonia amygdalina	sweet bitterleaf		15	5-20

Season Extension

Almost all of these species are managed with heavy pruning. If left on their own, the typical tree with edible leaves will go through a brief period with tender leaves (e.g. in spring in temperate climates), after which most leaves will quickly become tough and relatively inedible. Hard pruning techniques like coppicing and pollarding encourage robust regrowth. This regrowth will continue to produce tender leaves for a very long season. This includes availability in the tropical dry season for many species, a very important benefit. See Chapter 2 for details.

Benefits to Soils and Water

Perennial crops including trees with edible leaves offer a number of benefits, such as erosion control. They can improve soil health in a number of other ways including increasing soil organic matter and restoring degraded land. There is also reduced need for tillage, at least after the tree has been established, for the duration of its life (which can range from decades to centuries). A number of species also fix nitrogen, providing an additional fertility benefit.

Woody plants offer several water quality benefits as well. When planted on or near the contour of a slope, or along riparian areas, they can help filter out sediments and nutrient runoff, protecting water bodies from contamination. Their roots, which are deeper than those of annual crops, can capture nutrients that would otherwise leach away, returning them to the agroecosystem and preventing contamination of nearby water bodies or groundwater.

PROSPECTS FOR WIDER USE

Trees with edible leaves have never been more needed. They draw down extra carbon dioxide from the atmosphere, make farms and gardens more resilient to climate change, provide nutrients missing in the diets of billions of people, and provide a broader base of diversity to food production and diets. Generally speaking, they are easier to grow than annual vegetables. Given that world vegetable production needs to be tripled to meet humanity's nutritional needs, why not make trees with edible leaves an important component of that expansion?

Our hope is that this publication will increase awareness of these remarkable species, and that as a result many more people will plant trees with edible leaves in their gardens and farms. There is room to increase production even in the areas with the greatest richness of species. Other regions can follow Southeast Asia, temperate East Asia, West Africa, and Mesoamerica in scaling up production.

Figure 1.6. *Pseuderanthemum carruthersii,* a popular tropical ornamental and also an important food in its native Solomon Islands. Image courtesy Erica Klopf.

For most species the home garden is where the greatest potential currently lies, but many of these species are already marketed at least on a local scale and a few are important regional or export crops. Moringa provides us with a model of what kind of growth is possible. Moringa's success is due to the farmers in India who took it into cultivation long ago, and also to nutritionists and development workers like the team at Educational Concerns for Hunger Organization (ECHO) who have advocated for its wider use for decades. ECHO has distributed many thousands of packets of free seeds and cuttings of moringa, and other species including chaya and katuk, for decades. The World Vegetable Center is another powerful advocate for these species and a distributor of seeds and cuttings.

It's worth examining why moringa in particular has become such a success. It was already present as an ornamental in much of the tropics. It is adapted to drylands. It is also very easily propagated. Many other species profiled in this manual are in a similar position to where moringa was thirty years ago: they are widely grown as ornamentals (or for other reasons),

yet not consumed as vegetables outside of a relatively small region. Because these species are already widespread, they may represent a strategic place to begin. These globally distributed species include *Bauhinia purpurea, Ceiba pentandra, Morinda citrifolia, Morus alba, Pisonia alba, Polyscias* spp, *Pseuderanthemum carruthersii, Sesbania grandiflora,* and *Tilia* spp. Moringa's wide adoption is also in part due to its impressive nutrition. Many other tree leaves are remarkably high in the nutrients that humanity is missing. We hope that the information shared in this chapter and Appendix A will aid in promoting the cultivation and consumption of these species. Moringa has also been embraced as a "superfood" and an ingredient in many foods and supplements. While such popular fads may come and go, moringa and other trees with edible leaves could and should become a more integral part of farms, gardens, and cuisine around the world in the decades to come. Expanding humanity's partnership with these tree vegetables could help address some of our most pressing challenges.

The countries which have done the most to cause climate change are the ones who have brought the fewest trees with edible leaves into cultivation (with the exception of China). The countries which did the least to cause climate change, and are already suffering the most from it (with worse to come), have domesticated the overwhelming majority of cultivated tree vegetables. A way to redress this issue is for high-emitting countries, companies, and individuals to fund the increased adoption of trees with edible leaves in the tropics. This is a form of botanical climate justice.

While it seems like a very good idea to plant these species much more widely wherever they can grow, it is of vital importance to recognize and respect where they come from. History provides us with many examples of crops being developed without permission from or acknowledgement or financial benefit to the farmers and gardeners who labored for centuries or millennia to domesticate them. While trees with edible leaves like moringa are already widely grown, most species are regional crops, often grown only in a small area, typically primarily by smallholders. How best to increase the number of people growing these marvelous trees without leaving the people who introduced them to the world behind?

One such approach is the Nagoya Protocol on Access and Benefit Sharing. This supplement to the Convention on Biological Diversity focuses on the fair and equitable sharing of benefits, to recognize and reward the people who did the most work but are too often left out of the process of developing new crops. It requires the consent of the communities that developed the crops in the first place. Another strategy is to support efforts in the homelands of these crops, including research and adoption. For example, the Miracles in Action project supports adoption of chaya (*Cnidoscolus aconitifolius*) in Guatemala, where it was domesticated but is now very rare. Trees for a Future has undertaken similar work with African moringa (*Moringa* stenopetala) in its homeland Ethiopia, where it is extinct in the wild. The World Agroforestry Centre is at work on still another approach, to document and genetically fingerprint cultivars to establish records for the protection of the farmers who developed them.

As humanity faces a difficult century with climate, nutrition, and biodiversity crises, trees with edible leaves provide a pathway forward. The time is ripe for the rest of humanity to follow the lead of farmers and gardeners in the tropics, and in temperate Asia, in embracing a partnership with trees with edible leaves.

CHAPTER TWO

Growing Trees with Edible Leaves

Around the world, more than a hundred species of trees are grown for their edible leaves. They come from the Sahara and the Amazon, Indonesia and Nigeria, Siberia and Italy, from below sea level to the high Andes. Yet no matter where they originate, virtually all are grown using the same basic techniques. This remarkable fact is what makes a global manual on trees with edible leaves possible. What these species share is management based on aggressive pruning.

Hard pruning in various forms is used in almost all systems for growing trees with edible leaves. This offers several advantages. First, it keeps the leaves within easy reach of harvest. Figure 2.1 shows just how challenging it can be to harvest leaves from standard-sized trees. Easy harvest access due to severe pruning is a key component of low-maintenance tree vegetable production.

Figure 2.1 Harvesting leaves from full sized trees is highly hazardous, as shown with this baobab (*Adansonia digitata*) in Senegal. Image NoahElhardt, CC BY-SA 4.0.

Second, and crucially, the rapid regrowth that follows a hard pruning for most trees with edible leaves maintains tender growth for a long period. In a standard-sized tree, new growth might only be of edible quality for a few weeks, whereas fast-growing new shoots from an aggressively pruned tree remain tender for many months. In cold temperate gardens, species like linden, Chinese toon, and edible-leaf mulberry produce tender greens for four to six months when managed in this fashion. Otherwise, these same species would produce tender leaves for only two to three weeks before becoming tough and of poor quality for vegetable use. Similar results are seen in other climates.

A third benefit of aggressive pruning is that can extend the harvest well into the dry season in tropical and subtropical environments. This is important because fresh vegetables can be very difficult to come by during the dry season in many parts of the world.

This chapter provides information on these pruning approaches, along with both basic (coppice or pollard blocks and hedges) and advanced (various forms of agroforestry) production systems. Because there are already many excellent resources available about planting and growing trees and because the details of planting, pest management, and more can vary enormously from region to region and soil to soil, in this publication we've chosen to focus on information that is specific to trees with edible leaves, as well as an overview of propagation and caring for such trees.

There is also a lot to learn from tropical tree fodder systems, which are quite widespread and involve coppiced and pollarded trees grown to feed livestock. Though the end consumer is different, the practices for producing trees leaves are almost identical in many cases. In addition to the vegetable guides we consulted, we've used some tree fodder resources in assembling this chapter and recommend ongoing pursuit of new insights from this parallel practice.

Figure 2.2. A mixed-species demonstration fodder bank at Educational Concerns for Hunger Organization featuring the tree vegetables moringa, chaya, and mulberry. Image Eric Toensmeier, CC 3.0.

How long will these systems produce? Trees that are coppiced annually or more might produce for twenty to thirty years. Lopped trees and pollarded trees cut on a longer rotation (of, say, every four to eight years) can continue to produce for centuries.

PRUNING APPROACHES

The best approach will be different for different species. The right form of lopping, coppicing, or pruning can vary among and even within species. The illustrations in Figures 2.4 to 2.7 show examples.

In ***coppicing***, trees are cut back flush or very close to the ground and allowed to resprout. They are often cut annually, but sometimes two or even three times a year, and, in a few cases, once every two to three years. Coppicing is often used for dense, intensive plantings. It's the approach most likely to work well with a mechanized harvest, such as you might see for biomass, fodder, and medicinal products from woody plants. See Figure 2.4.

In ***pollarding***, trees are cut back to one to three meters high. This keeps foliage out of the reach of livestock, which is critical in areas where they are free-roaming (livestock often prevent the establishment of trees). Note that these trees will still need fencing or tree tubes to protect them from livestock until they are established. Here again harvest is usually annual, but sometimes on longer rotations up to four or even five years. Pollards may be of the ***tadpole*** type, cut back to a large, round head at the top of the trunk (see Figure 2.5), or ***candelabra*** style, with multiple branches all topped at one to three meters high (see Figure 2.6).

Finally, ***lopping*** is a form of pollarding where trees are permitted to branch, but shoots and leaves are harvested from each branch tip on a regular basis. See Figure 2.7. In livestock fodder systems, these are often on longer rotations of four to eight years, but we found little data on lopping systems for edible leaf production. In fodder plantings, lopped trees have higher yields than pollarded and coppiced plants. As in pollarding, lopped tree branches are safely out of the reach of livestock. However lopped trees may require more climbing to prune and harvest, which is labor-intensive and potentially hazardous.

As far as carbon is concerned, all of these pruning techniques can result in a lot of carbon storage in soil and living roots, but the more above-ground growth there is, the more carbon the tree will store. In other words, lopped trees and pollarded trees store much more carbon in their trunks (and branch stubs in the case of lopped trees) than coppiced trees.

Figure 2.3. A pollarded *Tilia* species grown for its edible leaves at the Agroforestry Research Trust in the UK. Image London Permaculture, CC BY-NC-SA 2.0.

Figure 2.4. Coppicing: before and after

Figure 2.5. Pollarding (tadpole style), before and after

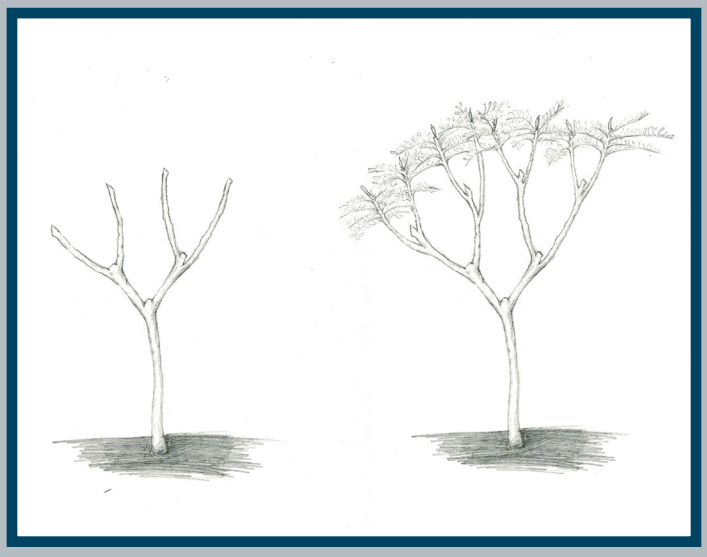


Figure 2.6. Pollarding (candelabra style), before and after

Figure 2.7. Lopping, before and after

BASIC PRODUCTION SYSTEMS

Each of these pruning approaches are used in several types of systems, including coppice blocks, hedgerows, and various agroforestry systems. The species profiles in the chapters to come describe what systems are used. In small home gardens, individual trees with edible leaves are often scattered here and there rather than grown in blocks or hedges.

Coppice and Pollard Blocks

Across climates and countries, coppice and pollard blocks seem to be the most widely used system for growing trees with edible leaves. Coppiced or pollarded trees are grown in dense blocks or row systems. Coppice and pollard blocks are often used in home gardens as well as in commercial-scale plantings of moringa, nopale cactus, and other species.

This same system is widely used to produce high-protein tree leaves for livestock fodder in both new and traditional systems around the world. Because these "fodder banks" are well understood, they make a good model for tree vegetable production systems. In fact, coppiced tree vegetable plantings are sometimes referred to as "human fodder banks."

Spacings depend on species, variety, climate, and management intensity. In drier climates, trees are planted farther apart to reduce competition for water (unless irrigated). Trees are also planted farther apart in less intensive systems, as they will grow larger if they are pruned or harvested less frequently.

Densities are very high, with trees very close together—much closer together than orchard trees, for example. That's because the trees are kept at a small size due to the frequent pruning. Commercial production of chaya is recommended at one meter between plants, for example, and moringa at 60 x 100 cm. Experienced tree vegetable grower Josh Jamison of Cody Cove Farm and Nursery recommends a wider spacing of at least 60 cm for most species, in double offset rows, with 150-180 cm pathways between. In our experience, coppiced and pollarded vegetable trees can quickly grow large and become crowded if planted too close together. However, intensive production of moringa and other trees can be at very close spacings, as close as 15 cm.

There's clearly quite a bit of variation in spacing and density. You may need to experiment. Species grown in these blocks include mulberry, nopale, moringa, chaya, castor aralia, and many others. Table 2.1 provides some sample spacings.

Figure 2.8. A pollarded block of *Moringa oleifera* at Educational Concerns for Hunger Organization. Image Eric Toensmeier, CC 3.0.

Table 2.1: Sample Spacings from Coppice and Pollard Block Systems
Note that these are usually planted on a much smaller scale than the hectare.

Species	System	Spacing (cm)	Plants per Hectare
Abelmoschus manihot	standard	100 x 100	10,000
Aralia elata	commercial	50-70 x 120-180	7,936 to 16,667
Cnidoscolus aconitifolius	standard, single row	60 x 150-180	
C. aconitifolius	commercial	100 x 100	10,000
Erythrina americana	standard	100 x 100	10,000
Ficus lacor	lopped	500 x 500	400
Kalopanax septemlobus	commercial intensive	50 x 150-200	10,000 to 13,333
Moringa oleifera	standard	60 x 100	16,667
M. oleifera	intensive	15 x 15	444,444
Morus alba	standard	200 x 300	1,667
M. alba intensive	intensive	50 x 60	33,333
Opuntia ficus-indica	standard	150-250 x 150-250	1,600 to 4,444
O. ficus-indica	intensive	30 x 30	
Vernonia hymenolepis	intensive	20 x 30	166,667

HEDGES

Another common system is to produce tree vegetables in hedges, often near the home for convenient daily harvest. Vegetable hedges are also often used at the edges of gardens or along the contour in sloping gardens. This technnique has arisen independently in different parts of the world, for example in Italy for tree purslane, in New Guinea for vegetable figs and *Polyscias* species, in Indonesia for katuk, in Japan for *Eleutherococcus,* in Mexico and Guatemala for chipilín, in Nigeria for sweet bitterleaf, and in Bhutan for laphet tea.

Figure 2.9. A hedge of *Polyscias fruticosa* (at center). Image Forest and Kim Starr, Creative Commons 3.0.

Harvest in hedgerows is often very frequent, with each branch cut approximately every two weeks. This can double as pruning, because hedges need to be trimmed to stimulate dense growth and maintain their shape. Hedge vegetables are often harvested weekly. A hedge ten meters long can produce a weekly yield of one kilogram (kg) of leaves for years. An outstanding old resource, but still available, is Kuchelmeister's 1989 manual *Hedges for Resource-Poor Land Users in Developing Countries.* A contemporary resource for cold climates is Krawczyk's 2022 *Coppice Agroforestry.* Table 2.2 provides sample spacings for hedgerows.

Table 2.2: Sample Hedgerow Spacings

Species	Spacing (cm)
Camellia sinensis	100 x 100
Polyscias spp.	30-100
Sauropus androgynus	10 x 10
Various tropical tree vegetables	5 x 5
European single-row hedgerows	23
European double-row hedgerows	46 x 38-61

TREES WITH EDIBLE LEAVES IN AGROFORESTRY SYSTEMS

Agroforestry systems are agricultural production systems that integrate trees. They include: silvoarable systems, which combine trees with crops (usually annuals); silvopasture systems, which combine trees, livestock, and forages; and multistrata systems, which combine multiple layers of woody (and sometimes herbaceous) crops in forestlike layers. Here it is silvoarable and multistrata systems which mostly concern us, though the many fascinating silvopasture systems that produce tree leaves for livestock provide an interesting parallel and inspiration.

Figure 2.10. In this small-scale commercial system from Florida, USA, a low hedge of shade-tolerant *Sauropus androgynus* is grown beneath banana rows. Image Eric Toensmeier, CC 3.0.

Silvoarable Tree Vegetable Systems
Typically, in these systems, rows of trees with edible leaves alternate with space for annual crops. When planted on slopes, the tree rows are planted on or near the contour line, for erosion control, as occasionally seen with moringa in the Caribbean. These rows may be coppiced, pollarded, or managed as hedges. Sometimes larger pollarded or lopped trees are grown in fields (see Figure X).

Nopale cactus and moringa are often grown in this kind of system. For example, rows of nopale cactus are intercropped between rows of annual crops in Mexico and with perennial cotton in Brazil.

In dry climates with sloping cropland, the tree vegetables are sometimes used to stabilize stone terraces. In Mexico, nopale cacti are grown on ancient *metepantli* terraces in the highlands. In temperate western China, *Toona sinensis* is used to stabilize cropland terraces on slopes as part of the Loess Plateau restoration effort.

If farm machinery is used, it's important that the spacing between the tree rows be a multiple of the width of the widest farm machinery. Coppicing or low pollarding (and/or frequent harvesting and pruning) is more desirable in these systems, as the shorter trees will cast less shade on their companion crops. Table 2.3 shows spacings from several sample systems.

Table 2.3: Sample Spacings from Agroforestry Systems
Note that these are usually planted on a smaller scale than the hectare.

Species	Description	Spacing	Trees per Hectare
Moringa oleifera	alley cropping	10 m between moringa rows	
M. oleifera	intensive intercropping	2-4 m between moringa rows	
M. stenopetala	dispersed trees in annual crop fields, Ethiopia		30-50
Morus alba	contour hedgerow	20-40 x 33-50 cm	
Opuntia ficus-indica	four nopale rows alternate with annual cropping lane	Lanes 3 m wide	
Vernonia hymenolepis	intensive intercropping in vegetable gardens	75 x 75 cm	17,778

Figure 2.11. A tropical homegarden with *Senna siamea* and *Sauropus androgynus* along with fruits and vegetables, immigrant Thai Lao garden in Florida, USA. Image Eric Toensmeier, CC 3.0.

Multistrata Agroforestry Systems
Tropical homegardens and temperate food forests. There are important roles for tree vegetables in these complex, carbon-rich agroecosystems. The most common multistrata system is the tropical homegarden, which is an ancient, highly biodiverse, multilayered system that today is sometimes called a "food forest." Tropical homegardens date back at least 10,000 years in Southeast Asia and elsewhere in the tropics. These systems frequently include trees with edible leaves like chaya, cassava, moringa, and katuk.

Food forest gardening has become much more popular in temperate climates in the last few decades. Tree vegetables like linden, edible-leaf goji, tree purslane, and Chinese toon are sometimes grown in these systems.

Multistrata and shade cropping systems. These agroforestry systems often produce commodities like cacao and coffee in the shade of larger trees. They are less diverse and intensive than homegardens and oriented toward commercial production. The biggest example of a tree vegetable in these systems is tea, which, fermented as *laphet,* is an important vegetable in Bhutan (see Figure 2.X). Any number of other trees with edible leaves could be grown in these systems.

In traditional Pacific Island agroforestry, large portions of islands were human-curated forests of species like breadfruit, Tahitian chestnut, banana, coconut, and trees with edible leaves like spinach jointfir, noni, and vegetable figs. In the shade below, species like pineapple, yams, taro, and turmeric are grown.

Many trees with edible leaves are shade tolerant. These are shown in Table 2.4. As a group, leaf vegetables tend to be more tolerant of shade than other crops. In fact, many make larger and more tender leaves in some shade. Shade tolerance is listed in the species profiles in the chapters to come.

Table 2.4: Shade-Tolerant Species for Agroforestry Understory Production
These species have potential to be grown in the shade of taller timber or crop trees. Many others are likely also tolerant but not reported in the literature.

Tolerant of partial shade	Tolerant of heavy shade
Aralia elata, Carica monoica, Chamissoa altissima, Clerodendrum glandulosum, Hypobathrum microcarpum, Oroxylum indicum, Piper auritum, Pseuderanthemum carruthersii, Rumex usambarensis, Sinclairia sublobata, Staphylea bumalda, Urera baccifera, Zanthoxylum ailanthoides	*Camellia sinensis, Carpolobia lutea, Eleutherococcus* spp., *Fagus sylvatica, Gnetum gnemon, Piper umbellatum, Polyscias* spp., *Sauropus androgynus, Tilia* spp., *Trichostigma octandrum*

Some tree vegetables are actually grown in agroforestry systems to *provide* shade for other crops like coffee. To manage them as vegetables in such a system, lopping or perhaps high pollarding could be used. These species include *Acalypha caturus, Erythrina* spp., *Ficus thonningii, Parkia timoriana, Pterocarpus* spp., *Senna siamea, Sesbania grandiflora,* and *Toona sinensis.*

Figure 2.12. Commercial multistrata agroforestry with tea under nitrogen-fixing alders.
Image World Agroforestry Centre, CC BY-NC-SA 2.0.

PROPAGATION

While this is not a propagation manual, here we provide a brief description of the propagation techniques used in production of trees with edible leaves. Here the techniques are presented in order of how important they are in the propagation of trees with edible leaves. Each species profile (in the chapters to come) also includes information on propagation techniques. Many of the resources mentioned Box 2.1 provide detailed information.

More specialized books like Miranda Smith's *Plant Propagators Bible* will provide additional detail. Another excellent resource is Roger Leakey's outstanding article "Low-Technology Techniques for the Vegetative Propagation of Tropical Trees," which is available as a free download online. It describes a method for growing difficult-to-propagate trees from cuttings without the use of a mist chamber or any electricity.

Figure 2.13. Moringa trees grown from seed in the nursery of Tom Mboya in Tanzania. Image Oertherdb, CC BY-SA 4.0.

Growing from Seed. Seed is the most widely used technique for the species profiled in this book. Growing from seed may be somewhat slower than vegetative techniques, but offers the advantage that the seedlings will each be genetically unique. This provides a more diverse genetic mix. Many species of trees with edible leaves are simple to grow from seed - just plant the seed in soil or potting mix. They are usually planted as deep as the seed is wide. A few species require extra help in the form of stratification and/or scarification. Some species from cold climates require *stratification* before they will germinate. This is a cold period, often 30-90 days. The easiest way to do this is to plant them in pots and leave the pots outside for the winter. As an alternative, seeds can be mixed with slightly moist potting soil and kept in the refrigerator or other cold but non-frozen storage for the specified time. *Scarification* involves breaking through the seed coat. You can nick the seeds with a knife, abrade them with sandpaper, or in some cases soak seeds in acid or pour boiling water over them.
Rooted Cuttings. Rooted cuttings are the second most common technique for trees with edible leaves. Softwood cuttings are taken from the tender, growing wood. Ideally the cut end is dipped in rooting hormone. They are planted in pots and

must be kept moist under plastic or in a misting chamber. (The Leakey article describes a low-technology technique to achieve the same results without electricity or mist sprayers.) Hardwood cuttings are ideally taken from dormant plants, at least in climates where the dry season or winter leads to dormancy. These are potted up, but (because they are dormant) do not require as much moisture management as softwoods. Note that in some cases, especially for humid tropical species, "cuttings" may refer to live stakes (see below).

Live Stakes and Cactus Cladodes. Live stakes are a very simple technique, mostly limited to tropical species, in which cuttings from branches are directly planted into the soil. The best-known species propagated in this way is cassava. Depending on species, these may be planted vertically, diagonally, or buried horizontally just below the soil surface. The desired diameter also varies between species, but tends to be thicker than ordinary cuttings, more like 5-10 cm. Nopale cacti are propagated in a similar manner. Pads are harvested and stored for several weeks and then buried halfway in the ground or in a pot.

Division of Suckers. For species that produce root suckers, a shoot and its attached roots can be dug up and transplanted to its new home or into a pot. This is a very simple system and is already familiar to many people because it is the method for dividing common plants such as bananas, hostas, or running bamboos.

Other Techniques. Some other techniques are used for a few trees with edible leaves. In basic *layering*, a branch is bent to the ground. Make sure it is in touch with bare soil. Weigh it down with a rock and pack a bit of soil or mulch around the edges. Come back in a year and it will have its own roots and can be separated from the mother plant. In *air layering*, the stem is scratched and moist soil is packed around the stem and wrapped with plastic. The stem will root into the soil, at which point the whole branch can be removed. *Root cuttings* are sections of root that are removed from the mother plant and potted up or planted on their own. *Grafting* is rarely used for vegetable trees but quite common in fruit propagation. It involves attaching a piece of a twig (the "scion") from the tree you wish to multiply to a potted, field-grown, or pre-existing tree of the same or similar species. *Tissue culture* is a laboratory technology for producing thousands of plants from as little as a single cell of the original plant you wish to propagate.

CARING FOR YOUR TREES

The care of trees with edible leaves is much like that of other heavily pruned trees such as those that make up hedges, coppiced and pollarded species, and some ornamental shrubs. See Box 2.1 for more general resources with relevant suggestions. Here we'll address a few techniques and concerns specific to trees with edible leaves.

Box 2.1: Resources on Gardening and Farming

The manual you are reading is exclusively focused on trees with edible leaves. The following resources provide broader, but highly relevant guidelines on soils, weed management, tree establishment, and general gardening and farming techniques. They are but a selection of the hundreds or thousands of excellent works on the subject. Full information on these resources is found in the References section.

- Berkelaar and Motis *Agricultural Options for Small Scale Farmers*
- Bloom and Boehnlein *Practical Permaculture for Home Landscapes, Your Community, and the Whole Earth*
- Bunch *Restoring the Soil: How to Use Green Manure/Cover Crops to Fertilize the Soil and Overcome Droughts*
- Crawford *How to Grow Perennial Vegetables: Low-Maintenance, Low-Impact Vegetable Gardening*
- Elevich *Agroforestry Landscapes for Pacific Islands: Creating Abundant and Resilient Food Systems*
- Kennedy *Leaf for Life Handbook: How to Combat Malnutrition and Improve Food Security with Green Leaf Crops*
- Krawczyk *Coppice Agroforestry: Tending Trees for Product, Profit, and Woodland Ecology*
- Kuchelmeister *Hedges for Resource-Poor Land Users in Developing Countries*
- Lancaster *Rainwater Harvesting for Drylands and Beyond*
- Meitzner and Price *Amaranth to Zai Holes: Ideas for Growing Food Under Difficult Conditions*
- Toensmeier *Perennial Vegetables: From Artichoke to 'Zuki' Taro, a Gardener's Guide to Over 100 Delicious, Easy-to-Grow Edibles*
- Studer and Liniger *Water Harvesting: Guidelines to Good Practice*
- World Neighbors Practical Guide to Dryland Farming Series including: *Introduction to Soil and Water Conservation Practices; Contour Farming with Living Barriers,* and *Planting Tree Crops.*

SITE SELECTION AND PREPARATION

Trees with edible leaves will live for many years, so it's important to give them a good start. First, the tree species must be matched with the site conditions. For example, only species which tolerate shade should be planted in shady areas. The same goes for different soil textures, soil drainage, soil pH, climate, rainfall, and so on. Weeds should be thoroughly eliminated before planting. Farmer experience has shown that if you don't remove aggressive perennial weeds like grasses, your trees may never achieve their potential. Use the opportunity to loosen compacted soils, amend with fertilizers as recommended by a soil test, and increase organic matter. In dry regions, you may wish to plant your trees as part of a rainwater-harvesting system. In more humid areas with poorly-drained soils, building raised beds and berms with better drainage will be important. Some growers use biointensive double-digging to prepare the soil for their trees with edible leaves, with excellent results. However these trees are somewhat less demanding than annual vegetable crops and can certainly produce well without such labor-intensive preparation.

ESTABLISHMENT

Your trees may initially grow more slowly than annual vegetables. In fact, in many cases you won't have your first harvest for six months or more. For example, when growing mulberries in the tropics, first harvest is five to six months after planting when trees are two to three meters high. In the case of growing tropical trees with edible leaves in hedges, as little as two months of waiting can be sufficient. Our own experience in temperate climates indicates that trees should not be seriously harvested until their second year. Lopped trees are usually not harvested for the first three years at least. The pruning and shaping required to set up your preferred pruning approach is a higher priority than harvest in the first year or two after planting.

Trees need to be protected from livestock and browsing wildlife with fencing, tree tubes, or other protection. Taller pollarded and lopped trees no longer need this protection once they are high enough to escape from livestock browsing (two to three meters high), but coppiced species will always require protection.

Figure 2.14. Mulberry leaf production from coppiced plants at the Bangladesh Sericulture Research and Training Institute. Those to the right are resprouting from a recent harvest, while those on the left are ready to cut. Image Nahid Hossain, Creative Commons 4.0.

MANAGEMENT

Like any vegetable, your trees with edible leaves will produce better with fertilization. This is especially true for high-yielding species like mulberry, moringa, and nopale. Table 2.5 presents sample fertilization rates from intensive systems. Nitrogen demand in these examples is even higher than in industrialized U.S. maize production. Intensive tropical fodder banks are another a good model for tree vegetable production. In Colombia, after each fodder harvest, 400-700 kilgrams (kg) of composted manure are applied. Some fodder bank producers intersperse a row of coppiced nitrogen-fixing trees every third (or even every other) row for fertility. You might wish to establish an herbaceous nitrogen fixing legume beneath your trees, like forage peanut or clover. This is recommended in tree fodder plantings. On the other hand, many producers don't fertilize at all and still achieve acceptable yields.

Table 2.5: Fertilization Requirements for Intensive Production

Species	Nitrogen rate kg/ha	Phosphorus rate kg/ha	Potassium rate kg/ha	Other
Cnidoscolus aconitifolius	370	225		
Moringa oleifera	350			
Morus alba	300	150	150	20 tons manure
Opuntia ficus-indica	275			

How often can you harvest? Because your trees will be actively growing for much of the year, it is possible to harvest as frequently as every two weeks from each tree in some cases, as with intensively managed hedgerows. Trees should be pruned back on longer rotations, typically between forty-five to ninety days in the tropics. Pruning is often at the end of the dry season in the tropics. Our temperate experience is that for slower-growing or less intensively-managed species, once a year in winter is sufficient, but once in mid-summer can create a nice new flush of growth and keep branches in easier reach for harvest. Letting your trees "fallow" occasionally and grow to a taller height will enable them to accumulate energy reserves for the following season. Even a few months without cutting can make a difference in the case of tropical legumes.

HARVEST

Globally, almost all harvest of trees with edible leaves is done by hand. For the home kitchen, only small amounts are needed each day and manual harvest is the best option. Commercial production appears to be largely manual as well, with a few exceptions. There are mechanical tea pluckers of various sizes, from hand-carried to self-driving, which might be suitable for other crops grown in hedgerows. Mulberry harvesters, used to pick individual leaves for silkworms, might also be useful for commercial tree leaf vegetable production. Unfortunately, most of the equipment used to harvest tree fodder for livestock (usually some form of silage or biomass harvester) will chop the leaves up along with the woody stems and therfore are not a good choice for vegetable use. Likewise, the equipment used for moringa is for harvesting leaves and stems for drying and pulverizing, and does not seem a perfect fit.

Picking and pruning may be one and the same, or different. You can pick leaves without harvesting the wood, but you'll still need to prune those plants as well. Leaves can be picked from the living wood for some species, while in others (like *Atriplex halimus*) the branches should be cut back at the same time to avoid disease. It won't take long to learn the best techniques for your trees once they have been in the ground for a few years.

Figure 2.15. Jonathan Bates of Food Forest Farm with *Toona sinensis*, USA. Image Eric Toensmeier, CC 3.0.

CHAPTER THREE

Species for Cold Climates

This chapter includes nineteen species from warm temperate, cool temperate, cold temperate, and boreal climates (USDA zones 3-8). Species from both humid and semi-arid climates are well represented, with rainfall requirements as low as 250 mm. There are also many interesting wild species from colder climates which we don't profile These include several dwarf arctic willows (*Salix alaxensis, S. phylicifolia,* and *S. pulchra*), and some promising species from temperate deserts (like Siberian elm *Ulmus pumila*). The Chilean mayten (*Maytenus boaria*), several North American birches (*Betula* spp), and perhaps a hundred or so other species are also worthy of trial as new vegetable crops. There are likely native species from each cold-climate region that are worthy of bringing into gardens. Perennial brassicas like tree collards could potentially be considered for this category but require staking if they are to reach their two to four meter potential height; otherwise they sprawl on the ground.

Temperate Asia is the home to a remarkable three quarters of cultivated woody plants from cold climates, contributing twelve species. China, Japan, and South Korea have led the way in taking these species into cultivation. Many are new crops, only becoming cultivated as urbanization and development make foraging no longer suitable for the majority of the population. Four species hail from Europe, two from Mesoamerica, and one each from South Asia and North Africa/Mediterranean/West Asia.

Figure 3.1. Blanched shoots of *Aralia elata*. Image im akatsu, CC BY 4.0.

Durep, Japanese Angelica Tree
(*Aralia elata*)
This spiny species is cultivated as a vegetable in South Korea. Improved varieties, some of which are spineless, include Choongbuk #1, "Nonsan #1, Pyeongbuk #1, Chang #1, Shungu, Zao, Wajao, Konkuk #1, Haettul #3, and Jeonggang. North America's *A. spinosa* is similar.
Family: Araliaceae
Names: English: Japanese angelica tree. French: aralia eleveé, angélique en arbre du Japon. German: Japanische aralie. Japanese: taranoki. Korean: durep, durepnamu. Mandarin Chinese: liao dong dang qui, cong mu, ci lao ya. Portuguese: aralia Japonesa. Spanish: aralia. Russian: aralija vysokaja. Wú Chinese: liao dong hu mu.
Form: A small tree, spiny, suckering, with large clusters of tiny white flowers.
Origin: Temperate Asia.
Climate and Soils: Growing from subtropics to boreal (USDA zones 4-9), humid, up to 2000 m elevation. Sun to part shade. Well-drained soils high in organic matter are important for commercial production.
Vegetable and Other Uses. The young shoots are a popular cooked vegetable in temperate Asia. This species also has medicinal uses.
Nutrition. Durep is very high in iron, zinc, and Vitamin E, and high in fiber and folate.
Growing System: It is planted in raised beds 120-180 cm wide, with 50-70 cm between plants. Cut it back to 20-30 cm height after the first year to stimulate branching. Commercially pruned to a candelabra shape at 1.5-2 m in height. This multi-stemmed shape permits harvest of more shoots per plant. After four to five years the plants will produce great numbers of harvestable new shoots from the base. Usually only one shoot is harvested from each branch each year in the spring, but plants are also grown in greenhouses for winter production.
Propagation: In commercial production in South Korea, root cuttings are the main propagation technique, used to clone elite vegetable forms. Horizontal roots 50 cm long are dug in the spring and sprouted. They are also propagated by digging suckers and by using tissue culture. To grow from seed, remove the fruit flesh from fresh seed and cold stratify. Germination is somewhat slow. Transplant from seed bed when seedlings have four or five true leaves.

Alismo, Tree Purslane *(Atriplex halimus)*
This species was brought into cultivation as a vegetable in Italy. Its leaves are extremely nutritious, but their high salt and oxalic acid content somewhat limit their potential. In terms of its nutrient content, it is a multi-nutrient species for industrial diet deficiencies.
Family: Amaranthaceae
Names: Arabic: al-quataf, maluh. English: tree purslane, saltbush. French: arroche halime, pourpier de mer. German: Strauchmelde. Italian: alismo, atriplice alimo, porcellana de mare. Portuguese: salgadiera. Spanish: álimo, armuelle glauco, marisma, orzaga, osagra, salgada.
Form: An evergreen, multistemmed shrub growing 2m high and 3m wide unless pruned.
Origin: North and East Africa, Mediterranean Europe, West Asia.
Climate and Soils: Tree purslane grows in conditions both arid (to the edge of the Sahara desert) and humid (the coasts of England). It is suited to subtropical and warm temperate conditions, to USDA zones 7 or 8. Tolerant of very salty, alkaline soils. Prefers well-drained, less fertile soils. Full sun.

Figure 3.2. *Atriplex halimus,* a highly nutritious vegetable cultivated in Italy. Image Krzysztof Ziarnek, Kenraiz, CC BY-SA 3.0.

Vegetable and Other Uses. The young leaves and stems are eaten. It is widely grown as livestock fodder, and used as a windbreak including in coastal areas.
Nutrition. This species is extremely high in calcium, iron, magnesium, and zinc, and very high in fiber. It's a top ten species for calcium, iron, magnesium, and zinc. However it can can concentrate toxic nitrates if excessive synthetic fertilizer is used and is very high in salt.
Growing System: Tree purslane is often grown as a hedge for vegetable production. It can be coppiced and pruned heavily. Don't leave bare branches when harvesting, as they are vulnerable to disease. Instead cut back the portion you have harvested.
Propagation: Softwood and hardwood cuttings are most commonly used. Tree purslane rarely sets seed. Seed should be presoaked and will germinate in two to three weeks.

Figure 3.3. *Camellia sinensis* is of global importance as the source of tea, but in its native Myanmar it is also a fermented vegetable consumed daily. Forest and Kim Starr, CC BY 2.0.

Laphet, Tea (*Camellia sinensis*)
This species is the source of cultivated tea, but in Myanmar it is also grown as a popular vegetable called *laphet.* Tea was domesticated in northern Myanmar and adjacent areas of China, and it is there in Myanmar that it is eaten as a fermented vegetable. In fact some 20% of all tea grown in Myanmar is grown for *laphet*.
Family: Theaceae
Names: Arabic: chai, shai. Assamese: chah-pat. Bengali: cha. Burmese: Laathpatrai. English: tea. French: théier, arbre á thé. German: Teestrauch. Hindi: chai, chai pata. Indonesian: teh. Japanese: cha-no-ki, cha, Taiwan-cha. Mandarin: cha, ch'a, pu er cha, ming. Marathi: chaha. Portuguese: chá, chá-da-Índia, chá-preto. Russian: čajnoe derevo. Spanish: té, árbol del té. Tamil: tea, thayilai. Telugu: nallateyaku, teyaaku, tiyaku. Urdu: chai, chai siyah.
Form: Small tree, usually grown as a hedge.
Origin: Myanmar and China.
Climate and Soils: While most commercial production of tea is grown in the highland tropics and subtropics, the plants are quite tolerant of cold. The common form, *C. sinensis assamica*, is cold hardy to -17˚C (0˚F, USDA Zone 7), and form *sinensis* survives -23˚C (-10˚F, USDA Zone 6). Ideal conditions are 1000-1200 mm rainfall, acid soils with pH under 5.8, and a long growing season. In the tropics tea can be grown up to 3,000 m elevation. It tolerates full sun to full shade, preferring partial shade. Acid, well-drained soils are preferred.
Vegetable and Other Uses. *Laphet* is surely one of the few caffeinated vegetables. The great majority of the world's tea production is used for oolong, black, green, and other teas. This species is also an extremely popular ornamental, with hundreds of named varieties.
Nutrition. This information is not available.
Growing System: Very widely grown in hedgerow systems. Frequently grown in partial shade in agroforestry systems. Usually planted 1 meter apart within rows. Also grown in dispersed plantings in diverse food gardens.
Propagation: To grow from seed, first soak in water and discard those that float. Cold stratification will improve germination. Seeds require six to eight weeks for germination. Also grown from rooted cuttings.

Figure 3.4. *Eleutherococcus trifoliatus* is one of four cultivated shrub vegetables in its genus. Image Krzysztof Ziarnek, Kenraiz, CC BY-SA 3.0.

Ezo-Ukogi, Siberian Ginseng (*Eleutherococcus* spp.)
Several *Eleutherococcus* species are cultivated as leaf crops in temperate and subtropical Asia. *E. sieboldianus* has been grown as an edible hedge in Yonezawa, Japan for centuries. *E. nodiflorus* is grown as a vegetable in South Korea. *E. senticosus* is also cultivated for its leaves in temperate Asia. *E. trifoliatus* is cultivated as a vegetable in subtropical southern Yunnan, China, but actually adapted to much colder climates as well. This genus was formerly known as *Acanthopanax* and plants are sometimes still sold under that name. In our taste tests, both *E. senticosus* and *E. sieboldianus* were quite bitter, with a strong taste of parsley, though neither were forms selected as vegetables. Nutrition of this genus appears to be outstanding. *E. senticosus* and *E. trifoliatus* are both multi-nutrient species for industrial diet deficiencies, while *E. senticosus* is also multi-nutrient for traditional malnutrition.

Family: Araliaceae
Names:

- ***E. nodiflorus.*** Mandarin Chinese: xi zhu wu jia.
- ***E. senticosus.*** English: Siberian ginseng, eleuthero. French: buisson du diable. German: Sibirischer ginseng, Stachelpanax, Taigawurtzel. Japanese: ezo-ukogi. Korean: gasiogalpinamu, gasiogapi. Mandarin: zu wu zha, ci-wu-jia, tz'u-wu-chia. Portuguese: ginseng siberiano. Russian: eleuterokokk koliuchii, svobodnoiagodnik koliuchii. Spanish: ginseng siberiano.
- ***E. sieboldianus*.** English: fiveleaf aralia. German: Siebolds Fingeraralie. Japanese: hime-ukogi, ukogi. Korean: ogalpinamu.
- ***E. trifoliatus*** English: Three-leaved eleuthero, climbing ginseng. Mandarin: san-ye-ci-wu-jia, bai-le. Vietnamese: ngu gia bi gai.

Form: Arching, sprawling, or (in the case of *E. trifoliatus*) climbing shrubs. Deciduous and spiny. Ranging from two to five meters in height. *E. senticosus* var. *inermis* is spineless.
Origin:

- *E. sieboldianus* and *E. senticosus:* Siberia and temperate eastern Asia.
- *E. trifoliatus:* Asia, from Himalayas to Southeast Asia and the Philippines.
- *E. nodiflorus.* Eastern Asia.

Climate and Soils: Sun to full shade for all four species. Humid regions but often with dry summers.

- *E. senticosus.* Warm temperate through boreal, to USDA zone 3.
- *E. sieboldianus.* Warm and cold temperate to at least USDA zone 5.
- *E. trifoliatus.* Cold temperate (to USDA zone 6), warm temperate, subtropics, tropical highlands (up to 3200 m elevation), tropical lowlands. Humid, sun to part shade.
- *E. nodiflorus.* Warm temperate through boreal, USDA zones 4-8.To 3000 m elevation.

Vegetable and Other Uses. The leaves are eaten cooked. All three species are commercially grown as medicinal plants.
Nutrition. *E. nodiflorus* is very high in fiber, magnesium, and zinc. *E. senticosus* is extremely high in fiber and Vitamin E, very high in iron, zinc, and Vitamin A, and high in calcium, folate, and Vitamin C. *E. trifoliatus* is extremely high in fiber and Vitamin A, and very high in calcium and iron. *E. senticosus* is is top ten species for fiber, folate, and Vitamin E, and *E. trifoliatus* is in the top ten for fiber.
Growing System: *E. senticosus* is grown as a vegetable using the hedge system. It's not clear what growing systems are used for the other species. These species are often grown as ornamentals, including a popular variegated form of *E. sieboldianus*.
Propagation: This genus is somewhat challenging to grow from seed. Seed is ideally sown when fresh. If stored, some *Eleutherococcus* species require six months of warm storage followed by three months of cold, moist stratification. Seed is slow to germinate. Fortunately these species can also be propagated with softwood and hardwood cuttings, root cuttings, and by digging up suckers.

European Beech (*Fagus sylvatica*)
The mildly sour, delicate leaves are eaten for a relatively short period in spring. Grown as a vegetable by European gardeners.
Family: Fagaceae
Names: Arabic: zan 'ubrubiyun. English: European beech. French: hêtre commun. German: Rotbuche. Japanese: yóroppa-buna. Mandarin Chinese: ōuzhōu shānmáojû. Portuguese: faia-europaea, faia. Russian: Buk yevropéyskiy. Spanish: haya común. Turkish: avrupa kayini, kayin.
Form: Large, standard, deciduous tree, sometimes suckering.
Origin: Europe.
Climate and Soils: Cold and warm temperate, USDA zones 4-8. Quite shade tolerant. Requires at least 700 mm of rainfall.
Vegetable and Other Uses. The young leaves are eaten raw or cooked. Trees occasionally produce small nuts. Also used as a timber tree.
Nutrition. Not available.
Growing System: For vegetable production beech is managed as a hedge or with coppicing or pollarding.
Propagation: Usually grown from seed, though suckers can also be dug up.

Figure 3.5. Tender leaves of *Fagus sylvatica* in the edible stage. I mage Botaurus, public domain.

Image 3.6. Cooked shoots of *Kalopanax septemlobus*. Author Ityoppyawit, CC BY 4.0.

Eumnamu, Castor Aralia (*Kalopanax septemlobus)*
South Korea is a world leader in taking wild edible plants into cultivation. Among them is eumnamu, grown and marketed for the young leaves. Varieties with green new growth are preferred as vegetables over those with red new growth. Varieties selected for shoot production including the thornless varieties "Cheongsong" and "Cheongsan", and the thorny but delicious "Cheongsun 1".
Family: Araliaceae
Names: English: castor aralia. French: kalopanax du Japon. German: Baumaralie, Baumkraftwurz. Japanese: harigiri, sen-no-ki. Korean: eumnamu, yin, eumnamusun, gae-durep. Mandarin Chinese: cíqiū, ci qui, ci qui shu pi.
Form: A medium deciduous tree with large leaves.
Origin: Japan, Korea, China and eastern Russian Federation.
Climate and Soils: Extremely hardy to cold, USDA Zones 4-8, perhaps even colder to -40C (-40F). Growing up to 2500 m elevation in China. Well-drained, fertile soils are best. Full sun is required. In its native range rainfall ranges from 800-2000 mm.
Vegetable and Other Uses. Young leaves and shoots are steamed and served as "namul" with sesame oil. Also used for timber and medicinal uses.
Nutrition. Very high in fiber, iron, magnesium, and iron, and high in calcium.
Growing System: Coppices and pollards well. Pruned into a multi-stemmed candelabra shape for production of young leaves for commercial production. Spacing is roughly 1.5-2 m by 0.5 m. Noted for naturalizing rather aggressively in North America.
Propagation: Propagated by seed, softwood cuttings, root cuttings, and grafting of selected varieties. Seed will take two years to germinate, to speed up the process requires two to three months of cold stratification or scarification (e.g. soaking in sulfuric acid for thirty minutes before planting).

Gou-Qi-Tou, Goji (*Lycium chinense*)
Cultivated as leaf vegetable in China. The closely related *L. barbarum* is grown for the edible goji fruit. A multi-nutrient species for industrial diet deficiencies.
Family: Solanaceae
Names: English: Chinese wolfberry. French: lyciet de la Chine, lyciet, kaoki. German: Chinesischer Bocksdorn. Indonesian: daun koki. Japanese: kuko, kuku. Korean: gugija. Mandarin Chinese: gou-qi-tou, gou qi. Portuguese: cambroeira da China. Spanish: cambronera de la China. Turkish: çin şeytan ipliği. Urdu: pagandi. Wú Chinese: di qu pi, you qi tou, gou qie.
Form: Thorny shrub, sprawling. Some varieties suckering.
Origin: Temperate and subtropical Eastern Asia.
Climate and Soils: Grows with as little as 300 mm of rainfall through much more humid climates. Cold temperate through subtropics, also highlands. To USDA zone 5. Full sun.

Figure 3.7. An edible-leaf form of *Lycium chinense*. Image Eric Toensmeier, CC 3.0.

Vegetable and Other Uses. This species is mostly grown for the edible leaves, though the fruit is sometimes used as well. Also has medicinal uses.
Nutrition. Extremely high in magnesium and Vitamin E; very high in iron, and high in calcium and Vitamin A. In the top ten for magnesium content.
Growing System: Grown as a hedge, but primarily coppiced as a leaf crop. Can be cut back in midsummer for second flush.
Propagation: Propagated with hardwood cuttings, by layering, and digging of suckers. Also fairly easily grown from seed.

Hong Sang, White Mulberry (*Morus alba*)
Though mulberries are best known as fruit and silkworm fodder, they are grown as a vegetable in East and Southeast Asia and also on a small scale in Latin America and Europe. Varieties with good flavor and texture include "Pendula", "Edible Leaf", and "Tigrinum". A multi-nutrient species for both traditional malnutrition and industrial diet deficiencies.
Family: Moraceae
Names: Arabic: tut 'ábyd, tout, tout helw. English: white mulberry. French: amomie, mûrier blanc. German: Weiber Maulbeerbaum. Hindi: tut, chinni, shatooth, tutri. Indonesian: bebesaran, besaran, murbei kertau, kertau. Japanese: kuwa, yama-guwa. Mandarin Chinese: hong sang, sang ye, sang. Marathi: tut. Portuguese: amoreira-branca. Russian: šelkovica belaja. Spanish: moral blanco, morera. Tamil: kamblichedi, pattuppuchi. Telugu: kamblai chettu, malabary akku.
Form: medium standard tree.
Origin: Central China. Listed in the Global Invasive Species Database.

Figure 3.8. Coppiced *Morus alba* under nitrogen fixing acacias, Las Cañadas, Mexico. Image Eric Toensmeier, CC 3.0.

Climate and Soils: Warm and cold temperate, with some varieties suited to boreal and some to tropical conditions. Semi-arid to humid. Not picky about soils, and a noted weed of urban areas.
Vegetable and Other Uses. Young leaves cooked. Dried mulberry leaf is added to many baked goods in China. More commonly grown for silkworm and livestock fodder, and for the edible fruit. While there have been news stories about deaths from overconsumption of mulberry leaf, these are inaccurate. According to the CBS story "Experts Question the Role of White Mulberry in Death of Congressman's Wife," mulberry is actually among the safest of all leaves humans ingest.
Nutrition. Extremely high in calcium and iron, very high in fiber, magnesium, zinc, folate, and Vitamin C, and high in Vitamin A. A top ten species for calcium, iron, folate, and Vitamin C.
Growing System: Typically grown in fodder bank system when grown for leaves. Harvested twice a year in temperate climates and more frequently in the tropics.
Propagation: Propagated with hardwood cuttings, grafting, and air layering. Some growers use layering. In the tropics commonly grown from live stakes, but this appears less successful in temperate areas though this may have more to do with the variety than the climate. Growing from seed requires four months of cold stratification.

Nopale Cactus, Prickly Pear (*Opuntia ficus-indica*)
See Chapter 4.

Figure 3.9. Fragrant leaves of the shade-tolerant shrub *Piper auritum* are often used as edible food wraps in Mexico.
Image Forest and Kim Starr, CC BY 2.0.

Hoja Santa, Root Beer Leaf (*Piper auritum*)
Grown as a vegetable in Mesoamerica. The raw leaves have a strong flavor of root beer and anise. Once cooked, hoja santa is mild flavored with a texture like spinach.
Family: Piperaceae
Names: English: root beer leaf. Maya names: obet, obel, maculan, momo. Other Mexican Indigenous names: acoyo, acuyo, jaco, tampa, tlanepa. Nahuatl: mecaxóchitl. Quechi: xaclipur. Spanish: hoja santa, hierba santa, acuyo.
Form: Thicket-forming shrub or occasionally small tree.
Origin: Tropical Americas from Mexico through Colombia.
Climate and Soils: Tropics, subtropics, and warm temperate climates through USDA zone 8. To 1800 m elevation. Produces well in sun or partial shade. Humid.
Vegetable and Other Uses. Leaves are eaten as a vegetable or used as an edible food wrap for tamales. Young, peeled stems are an excellent vegetable as well.
Nutrition. Extremely high in iron and very high in calcium. Part of the flavoring comes from the chemical safrole, which can cause cancer in rodents. Safrole is also found in many commonly consumed herbs and spices like basil and cinnamon.
Growing Tips. Can be an aggressive weed outside of its native range.
Propagation. Grown from seed and divisions.

Shuang-Hu-Die, Bumald Bladdernut (*Staphylea bumalda*)
This species has long been a wild edible in China and is now being cultivated as a vegetable and for its edible oil. It is grown as an ornamental in temperate Europe and North America and is available from nurseries and seed companies in those regions.
Family: Staphylaceae
Names: English: Bumald bladdernut. Mandarin Chinese: sheng-gu-you, sheng-ku-yiu, zhen-zhu-hua, chen-chu-hua, shuang-hu die-shuang-hu-tieh.
Form: deciduous shrub or small tree, 2-5m tall.
Origin: Temperate East Asia.
Climate and Soils: Humid temperate, sun to part shade. Subtropics, warm temperate, cold temperate to USDA zone 4.
Vegetable and Other Uses. The leaves, flowerbuds, and flowers are all eaten as cooked vegetables. An edible oil is pressed from the seeds.
Nutrition. Unavailable.
Growing System: Can be grown as a hedge.
Propagation: Seed can be planted outdoors as soon as seed is ripe, and some will germinate the following spring. Stored seed is more complicated. First scarify and soak in water for twenty-four hours. Then cold stratify for ninety days, and then sow seeds. Also cuttings of half-ripe wood and layering.

Figure 3.10. *Staphylea bumalda,* one of the world's newest cultivated vegetables.
Image Wendy Cutler, CC BY-SA 2.0.

Lime, Linden (*Tilia cordata, T. platyphyllos, T. x vulgaris*)
One of few tree vegetables of European origin, linden has mild-flavored leaves with a mucilaginous texture. At present it is a garden crop rather than a commercial one. The Polish variety of *T. cordata* "Bierun" has superior flavor according to linden crop champion Goran Christiansson.
Family: Malvaceae
Names:

- ***T. cordata:*** Arabic: zayzifun, khashab alzayazafun. English: littleleaf linden, lime tree. French: tilleul á petites feuilles. German: Winterlinde, Steinlinde. Japanese: fuyu bodaiju. Russian: lipa serdtselistnaya. Spanish: tilo norteño, tilo de hoja pequeña. Turkish: küçük yaprakli ihlamur.

Figure 3.11. *Tilia cordata* is a mild-flavored, productive vegetable. Image Eric Toensmeier, CC 3.0.

- ***T. platyphyllos.*** English: large-leaved linden, large-leaved lime. French: tilleil á grandes feuilles. German: Sommerlinde. Japanese: natsu-bodaiju. Mandarin Chinese: kuó yé duán. Russian: lípa krupnolístnaya. Spanish: tilo de hoja ancha. Turkish: büyük yaprkli ihlamur.
- ***T. x vulgaris:*** English: common linden, common lime. French: tilleul commun. German: Holländische linde. Spanish: tilo híbrido de Holanda.

Form: Large deciduous tree, with suckering from the base.
Origin: *T. cordata* is native to Europe and West Asia, while *T. x europaea* is a natural hybrid found in Europe.
Climate and Soils: These species are suited to warm temperate through boreal climates, USDA zones 3-7. Quite tolerant of shade. Semi-arid to humid. Tolerant of urban soils.
Vegetable and Other Uses. Tender leaves eaten raw or cooked. The flowers are a popular medicinal herb. The wood is used in woodworking and the leaves are used as fodder. A popular landscape tree. Historically important for fiber and cordage.
Nutrition. *T. cordata* is high in zinc.
Growing System. Coppiced for leaf production.
Propagation: *T. cordata* is mostly grown from seed. Requires six to nine months of cold stratification. Improved varieties can be propagated by grafting.

Figure 3.12. Bundled leaves of elite pink-leaved *Toona sinensis* for market. Image Tencent, CC BY-SA 4.0

Xiang Zhon, Chinese Toon (*Toona sinensis*)
A commercially important, cultivated vegetable in China and South Korea, Chinese toon is noted for its strong flavor of meat and garlic which has been compared to chicken soup. Indeed, wehnwe fed it to chefs from Noma in Copenhagen (holder of a three Michelin star rating), they suggested calling it "chicken soup leaf." Pink-leaved forms are considered especially desirable. A multi-nutrient species for both traditional malnutrition and industrial diet deficiencies.
Family: Meliaceae
Names: English: Chinese toon. French: acajou de Chine, chanchin. German: Chinesischer Surenbaun. Hindi: darlu, durloo. Indonesian: suren. Japanese: agatsura, chan-chin. Mandarin Chinese: xiang zhon, ch'un, xiang chun. Spanish: caoba china, chino toon.
Form: Suckering medium deciduous tree.

Origin: Native to South, Southeast, and East Asia.
Climate and Soils: Warm temperate, subtropical, and tropical highlands (USDA zones 6-10). Humid to semi-arid, down to 250 mm of rainfall.
Vegetable and Other Uses. In addition to the young leaves, the sprouted seeds and very young plants are also commercially grown as vegetables. Also used to provide shade for coffee, and as a timber tree.
Nutrition. Extremely high in iron and Vitamins A and E, very high in calcium and zinc, and high in fiber and Vitamin C. A top ten species for Vitamins A and E.
Growing System: Grown in coppice and pollard systems. Sometimes intercropped with annual vegetables.
Propagation: Easiest from root cuttings and division of suckers. Seed must be cold stratified 2-3 months, and benefits from soaking twenty-four hours before planting.

Figure 3.13. *Zanthoxylum ailanthoides* is a spicy vegetable cultivated in eastern Asia. Image Krzysztof Ziarnek, Kenraiz, CC BY-SA 4.0.

Karasu-Zanshó, Japanese Prickly Ash (*Zanthoxylum ailanthoides*)
Cultivated as a leaf vegetable and culinary crop in eastern Asia. It has a strongly spicy flavor that for some is more an herb than a vegetable.
Family: Rutaceae
Names: English: Japanese prickly ash. French: cayratia japonica. Japanese: karasu-zanshó, angi. Mandarin Chinese: Shí zhūyú hóng cì cōng, chun ye hua jiao, tang tzu, shi chu yu, yueh chiao. Spanish: ceniza espinosa japonica.
Form: Medium-sized standard deciduous tree. Very spiny.
Origin: East and Southeast Asia.
Climate and Soils: Sun to part shade. Warm temperate (to USDA zone 8) to tropical, elevations 300-1500 m.
Vegetable and Other Uses. Young leaves breaded and deep fried or used as culinary herb. Dried fruit used as a spice like the related Szechuan and Sansho peppers.
Nutrition. Extremely high in calcium, very high in iron, zinc, and Vitamin C, high in Vitamin A, and medium in fiber and folate.
Growing System: Grown commercially for the leaves in coppiced orchard plantings with multiple cuttings per season. For seed production both male and female plants are needed.
Propagation: Grown from cuttings and suckers. Seed requires 2-3 months of cold stratification, followed by one to two days of soaking in water before planting.

CHAPTER 4

Species for Tropical and Subtropical Drylands

Here we profile thirty-three species from arid and semi-arid tropical and subtropical regions. Arid in this case means under 250mm rainfall per year, and semi-arid means 250-1000 mm, though length of dry season is also of critical importance. The habitats these species are suited for include savanna, desert, and grasslands. Many other presently uncultivated species are worthy of consideration.

The majority of these eleven species are from Mesoamerica, the region that includes Central America, the Caribbean, and most of Mexico. Southeast Asia provides seven, sub-Saharan Africa six, and three each from South America, South Asia, and temperate Asia. The Mediterranean/West Asia/North Africa region has one species (some species are native to more than one region).

Many species classed as tropical actually produce leaves well in the subtropics. They are killed back by frost but resprout with plenty of leaves. This "frost coppicing" has a similar impact to severe pruning like coppicing and can stimulate vigorous growth. While such trees are unlikely to flower and set seed, they are perfectly useful as vegetables. Moringa and baobab are among the species that respond to frosts in this way.

Baobab (*Adansonia digitata*)
Baobab has been an important wild food since the dawn of humanity. Today it is becoming a market leaf crop to meet the demand. Climbing the large trees for harvest is challenging, so coppiced systems are being used instead.
Family: Malvaceae
Names: Afrikaans: kremetart. Arabic: hijid, hamar, hamaraya, el omarah. Bafok: njobwih. Baga: kö-basera, kö. Balanta: laté, Bassari: a-mák, niturr. Batonnun: chonbu. Baule: fromdo. Bedik: a-mák, ga-mák. Bengali: gadhagachh. Bidyogo: uáto. Biomba: toreg. Bisa: mor. Brong: ala, nilai. Busa: fon, kuka. Dagaari: tuo. Dera: kúrnjé. Diola: babaq, bubakabu, ebakai. Edo: úsí. English: baobab. French: baobab, pain de singe, calebassier du Sénegal. Fula-Pulaar: boiö, boki, boré. Ga: sáalo, sháaje. Gen: dido. German: Affenbrotbaum. Grusi-Lyela: kukulu. Hausa: kuka, bumbu, kubali, kulambi. Hindi: gorakh imli. Igala: obobo. Kabre: taleu. Kanuri: kálkúwá. Kinkomba: nitule. Kono: sela. Konyagi: a-mbu. Koosi: njobwele. Kru-Guere: go. Kundu: ngubwele. Kweni: bélé. Limba: kutidi. Loko: sakwi mbawi. Long: njobwih. Lundu: njubwele. Manding-Bambara: mólódo, sito, tedum. Mandinka: sira, sito. Maninka: sira. Mandyak: bebaque, bedom-hal, brungal. Mankaya: bedôal. Marathi: gorakh chinch, vavabab. Mbongwe: ngubwele. Moore: toéga. Nabt: tuwa. Nankanni: tua. Non: bak, ibak. Nzema: ekuba. Pepel: burungule. Portuguese: baobab, baobá, imbondeiro. Serer: bak, mbak. Serer-Non: ba, boh. Soce: sito. Singhai: kó. Sisaala: telin. Somba: turubu. Soninke-Sarakole: kide. Spanish: baobab africano, árbol de pan de mono. Susu: kiri. Swahili: mbuyu, mkuu hapingwa, mkuu hafungwa, muuyu. Tamil: papparappuli, periyamaravakai. Tanga: ngubwele. Telugu: brahmaamlika. Tem: taleu, telu. Transvaal: kremetalboom. Vhe: dindo dodo. Wolof: bui, gui. Yom: tolro.
Form: Large deciduous trees with swollen trunk.
Origin: Africa.
Climate and Soils: Tropical lowlands to 600 m, occasionally as high as 1,000 m. Rainfall ranges from 100 mm to 2000 mm or more. It resprouts after frost.

Figure 4.1. Harvest of *Adansonia digitata* leaves from coppiced plants. Compare to the full-sized tree in Figure 2.1.

Vegetable and Other Uses. Baobab is considered the most useful plant in West Africa. In addition to the edible leaves, it has edible fruit and seeds. Oil, dye, fiber, and fodder are among its many other uses.
Nutrition. Baobab is very high in calcium, zinc, and Vitamin E, and high in iron.
Growing System: While traditionally the large trees are climbed to harvest the leaves, this can be quite dangerous in a tree 20m high. Coppicing and pollarding are used in some commercial production systems.
Propagation: Mostly grown from seed. Most sources recommend boiling seeds for 5-7 minutes, after scarifiying by filing a crack in the seed coat. Josh Jamison reports that some baobab seeds germinate without any boiling or scarification. Improved varieties are grown from rooted cuttings or grafted.

Alismo, Tree Purslane (*Atriplex halimus*)
See Chapter 3

Figure 4.2. *Adazirachta indica* is primarily grown for medicinal and pesticidal uses but is a cultivated vegetable in Thailand.
Image Forest and Kim Starr, CC BY 3.0.

Neem (*Azadirachta indica*)
Neem is cultivated as a vegetable in Thailand for its intensely bitter edible leaves and flowers, which are marketed in bundles together. A multi-nutrient species for industrial diet deficiencies.
Family: Meliaceae
Names: Arabic: shereesh, neeb. Bengali: neem, nim. English: neem. French: margosier. German: Niembaum. Hindi: neem, balnimb. Indonesian: mimba. Lao: kadau. Marathi: nimbay, balantanimba. Portuguese: margosa. Tamil: sengumaru, vembu, veppa, veppai. Telugu: vepa, numbamu. Thai: khwinin, sadao, saliam. Urdu: neem, burg neem.
Form: Small to medium evergreen tree.
Origin: South and Southeast Asia.
Climate and Soils: Growing with as little as 400 mm of rainfall, or up to 2,500 mm in well-drained soils. Lowland tropics and subtropics to as high as 1500 m. Very adaptable in soils, from pH 3-9. Will produce as a vegetable in saline, marginal, and degraded soils.
Vegetable and Other Uses. Grown as a vegetable in Southeast Asia, but more widely grown for the fruit's pesticidal oil and for medicinal uses. Used in many agroforestry applications like windbreaks. Often found in tropical homegardens.
Nutrition. Extremely high in fiber, very high in iron, and high in calcium, Vitamin A, and Vitamin C. A top ten species for fiber.
Growing System. Coppices well. Neem has the potential to be weedy in certan environments.
Propagation. Best grown from fresh seeds. Soak from one to two days, remove pulp from seed and sow or dry for later use. Also propagated from cuttings, root cuttings, and air layering.

Dyamo, Balanites (*Balanites aegyptiaca*)
Balanites is cultivated in Ethiopia and Egypt for the edible leaves and flowers. A multi-nutrient species for industrial diet deficiencies.
Family: Zygophyllaceae
Names: Amharic: dyamo, ghosa, shifaraoul, chossa, djeme, ghoss, kachona, kudkudda. Arabic: heglic, zachun, zaccone, hajlyj. Bileninya: selibatiqo. English: desert date, balanites. French: dattier du désert, héglik. German: Zauchenbaum. Hausa: aduwa. Hindi: hingan, baam. Marathi: hingalbet, hingam. Oromo: adagog-negole, badana, domoho, keglik. Spanish: mirobalano de Egipto. Swahili: njierjia. Tamil: nanchundan, toruvattu. Tigrinya: nogah, qok, quassa. Urdu: hingot.
Form: Multistemmed tree or large shrub.
Origin: Native from the heart of the Sahara Desert through West and South Asia to Myanmar.
Climate and Soils: Suited to very dry regions, typically from 250-800 mm rainfall but tolerating as little as 100 mm. From below sea level in salt basins to up to 1800 m in elevation. Tolerates intense heat and drought. Full sun. Not tolerant of frost.

Vegetable and Other Uses. Leaves and flowers are cooked in sauces or boiled and added to peanut balls, and are also eaten raw. The fruits and nuts are also edible, and balanites is cultivated for its fruits and nuts in parts of eastern Africa. The tree is also an important source of fodder and firewood. Bark can be used as a poison to kill the organisms that host bilharzia and Guinea worm.
Nutrition. Extremely high in fiber and Vitamin E, very high in iron. A top ten species for fiber and Vitamin E.
Growing System: Balanites can be very weedy; it is spiny and has suckers. It may not be wise to plant outside of its native region, though that spans much of the world's great deserts. Balanites coppices vigorously.
Propagation: It can be grown from seed, especially seeds that were swallowed by livestock or boiled for seven to ten minutes. Root cuttings are also used.

Figure 4.3. *Balanites aegyptiaca* is a vegetable tree of African and Asian drylands. Image Trees for the Future, CC BY.

Figure 4.4. *Careya arborea,* a vegetable crop of Southeast Asia. Image Yercaud-elango, CC BY-SA 4.0.

Kradone, Kumbha (*Careya arborea*)
Cultivated as a vegetable in Southeast Asia including Thailand.
Family: Lecythidaceae
Names: Assamese: kumari, kumbhi, kum kumari, kumrega, panibhela. Bengali: kamber. English: Kumbha. Hindi: kumbhi, pilu. Khmer: kandaol: Malay: putat kedang. Marathi: kumbhi, kamba. Tamil: avima, kampi, kumpi, pelaimaram. Telugu: kumbhi, araya. Thai: Kradone. Vietnamese: Vú'ng
Form: Small deciduous tree.
Origin: Tropical and subtropical Asia.
Climate and Soils: Deciduous forests, savannas, and grasslands. Rainfall of 500-3230mm. Well-drained soils, full sun.
Vegetable and Other Uses. Young leaves and tender twigs are eaten. Also has edible fruit, but poisonous seeds. Used as medicine, fodder for silkworms, and as a timber tree. Produces fiber, gum, and tannins. An important fodder species.
Nutrition. Not available.
Growing Tips. Coppices well. Fire resistant.
Propagation: Seeds are direct sown at the beginning of the rainy season.

Sumaúma, Ceiba (*Ceiba pentandra*)
Some members of the Plantas Alimentícias Não Convencionais (Unconventional Food Plants) movement in Brazil there are cultivating ceiba as a new leaf vegetable. Grown in the tropics worldwide as an ornamental and fiber plant. It is also native to tropical Africa, where the leaves of wild trees are sold in markets as vegetables.
Family: Malvaceae
Names: Bengali: schwetsimul. English: kapok tree, silk cotton tree. French: arbre kapok, cottonier faux, fromager. German: Kapokbaum. Hindi: shalmali, safed savara, safed semul. Indonesian: kapok, kapuk, randu, kabu-kabu. Japanese: kappoku, Indo-wata-no-ki. Mandarin Chinese: jí béi. Marathi: safeta savara, pandhari. Nahuatl: pōchōtl, chichicahuitl. Portuguese: sumaúma. Russian: Khlópkovoye dérevo. Spanish: ceiba, pochote. Tamil: elavam, panji, ulagamaram. Telugu: tella buruga. Turkish: kapok. Urdu: semal, shalmali.

Figure 4.5. *Ceiba pentandra* is native to both Latin America and Africa, and the leaves are eaten on both sides of the Atlantic. Image José Ramón Fernández, CC BY-SA-NC-SA 2.0.

Form: Gigantic deciduous tree, in some cases with extremely spiny trunk and butressed roots.
Origin: Tropical Americas and likely also western and central Africa.
Climate and Soils: Prefers lowland tropics but reported from as high as 4000 m. Rainfall from 750-3000 mm.
Vegetable and Other Uses. A multipurpose tree. Young leaves are cooked, as are the young fruits, flowers, and flowerbuds. Seeds are eaten and used to press edible oil. A cultivated fiber plant, important timber species, and iconic ornamental.
Nutrition. Extremely high in iron and magnesium, very high in zinc, and high in calcium. A top ten species for magnesium content.
Growing Tips. Coppiced, pollarded, or lopped for leaf production.
Propagation. Grown from seed. Scarify and soak for twenty-four hours or boil for five minutes. Seed is best sown fresh. Also grown from cuttings.

Mofungo-Gigante, Tall Chamissoa (*Chamissoa altissima*)
This species is cultivated as a leaf crop in Brazil. It is a shrub that likes to sprawl or climb, but when coppiced for leaf production it becomes more shrublike.
Family: Amaranthaceae
Names: English: tall chamissoa. Nahuatl: cuamecate. Portuguese: espinafre-trepador, espinafre-selvagem, mofungo-gigante, erva-de-pombas. Spanish: guanique, hierba de arlome.
Form: A sprawling shrub.
Origin: Tropical Americas.
Climate and Soils: Humid and semi-arid tropical lowlands, sun to partial shade.
Vegetable and Other Uses. The cooked leaves are used as a vegetable, and the roots are used medicinally. Seeds can be used as a pseudocereal like the related amaranth and quinoa.
Nutrition. Unavailable.
Growing Tips. Coppiced for leaf production.
Propagation. Grown from seeds, rooted cuttings, and division of suckers.

Figure 4.6. *Cnidoscolus aconitifolius* grown in the candelabra pollarding system, Educational Concerns for Hunger Organization. Image Eric Toensmeier, CC 3.0.

Chaya, Maya Spinach (*Cnidoscolus aconitifolius*)
Chaya was domesticated by Maya farmers in ancient times. It is one of the most reliable and widely adopted species in this manual – and palatable to a broad audience as well. Leaves are high in cyanide and must be thoroughly cooked for at least five minutes. Flavor and texture are excellent, including both the leaves and thick, tender shoots. Some varieties have painful stinging hairs with an effect that can last for days. A multi-nutrient species for both traditional malnutrition and industrial diet deficiencies.
Family: Euphorbiaceae
Names: English: chaya, Mayan spinach. French: manioc batard, ricin batard. German. Baumspinach. Indonesian: pepaya jepang. Maya Ch'orti': chatate. Other Maya names: chaya, chichicaste, chayo, chaidra, chaira, tzah, ay uutikuua. Other Indigenous Mexican names: chay, caya pica, laec, tza, ts'in'k-chay, tzintzin, tziminchay, x'tsah. Portuguese: chaya. Spanish: chaya, manolo, papayuelo.
Form: Shrub or small tree.
Origin: Mesoamerica.
Climate and Soils: Tropics and subtropics, lowlands to 1300 m or occasionally 1500 m or higher. Rainfall 500-2500 mm. Suitable for coral atolls.
Vegetable and Other Uses. Cooked leaves and shoots. Also used as a living fence. Earns its reputation as an easily grown, low-maintenance vegetable.
Nutrition. Extremely high in iron and Vitamin A, very high in calcium, magnesium, and Vitamin C. A top ten species for Vitamins A and C.
Growing Tips. Typically coppiced or pollarded, sometimes grown as a hedge. Many different varieties have been selected.
Propagation. Grown from live stakes and rooted cuttings.

Figure 4.7. *Erythrina americana,* one of several vegetable crops in its genus. Image Linda de Volder, CC BY-NC-ND 2.0.

Pito, Coral Bean (*Erythrina americana, E. mexicana*)
While the flowers of this genus are a more popular vegetable in the Americas, these two dryland species are cultivated as leaf vegetables as well.
Family: Fabaceae
Names:

- ***E. americana:*** Chinanteca: ma-ja-ñú. Chontal: li-pa-shcua. English: coral bean. Mixe: tsejch. Nahuatl: equimit, tzompancuahuítl, tzompantli. Otomí: chotza. Spanish: pito, colorín, piñon, iquimite. Tetelcingo: tzompomitl. Totonaca: lakatilo, tlalni. Yucatec: chak-mol-ché, xoyo.
- ***E. mexicana:*** English: coral bean. Other Indigenous Mexican names: betusagitse, ma-hñá, ma-ho-ñá. Nahuatl: zupantle, zompantle. Spanish: betusagitse

Form: Both species are spiny medium deciduous trees.
Origin: Central America and Mexico.
Climate and Soils: *E. americana* from 1000-2100 m, *E. mexicana* from 600-1500 m. Both species semi-arid and humid and tropics, with *E. americana* subtropical as well.
Vegetable and Other Uses. Young leaves cooked. The flowers are a very popular vegetable. Grown as a living fence, living trellis, shade for coffee and cacao. Seeds highly poisonous.
Nutrition. Not available.
Growing Tips. Planted at 1x1m for fodder bank production. Both species coppice well. Both are nitrogen-fixing legumes. If inoculant is needed use cowpea *Bradyrhizobium*.
Propagation: Grown from live stakes. Can be grown from seed, pour boiling water over the seeds and soak for twelve to twenty-four hours before planting.

Kabhro, Cluster Fig (*Ficus lacor*)
Of the many figs reported to be cultivated in Asia for their edible leaves, the cluster fig is the only one suited to drylands. It is grown as a vegetable in Southeast Asia, Nepal, and perhaps elsewhere.
Family: Moraceae
Names: English: cluster fig. Hindi: pakar, pakur, kahimal, keol, pilkhan. Javanese: elo, lo, loh. Madurese: arah. Marathi: bassari, dhedumbara. Nepali: kabhro. Sundanese: loa. Tamil: icci, kallicci. Telugu: banda juvvi, jati. Thai: phak huat.
Form: Medium to large deciduous tree, nearly evergreen.
Origin: Tropical Asia.
Climate and Soils: Up to 1500 m, subtropics, 500-4000mm.
Vegetable and Other Uses. Leaves cooked as a vegetable or pickled. Also an important livestock fodder plant.
Nutrition. Not reported.
Growing Tips. Coppices well. Spaced at 5x5 m for lopped or pollarded fodder production.
Propagation. Easily grown from live stakes 2 m long, can also be grown from the tiny seeds.

Figure 4.8. *Ficus lacor,* an Asian dryland vegetable tree. Image Krish Dulal, CC BY-SA 3.0.

Figure 4.9. *Ficus thonningii,* a wild food across Africa and a leaf crop in Benin. Image Bernard Dupont, C BY-SA 2.0.

Boukamkambou, Bark-Cloth Fig (*Ficus thonningii*)
A popular African wild edible, also grown as a leaf vegetable by some gardeners in Benin. It is popular in part because the leaves are available in the dry season.
Family: Moraceae
Names: Arabic: djadjan, jammeiz al abiad. English: bark-cloth fig, Chinese banyan, common wild fig. French: figuier á pagnes, figuier-palabre, figuier des places. Gourmantché: boukamkambou. Mandarin Chinese: tong shi rong. Portuguese: incendiary, micendeidra, sicomoro-figueira. Swahili: mlandege, mrumbapori, mtschamwa.
Form: Large evergreen tree, a banyan-type fig with aerial roots which establishes as an epiphytic strangler fig on other trees.
Origin: Tropical Africa.
Climate and Soils: Tropics. Elevation 1000-2500 m, rainfall from 600-2500 mm.
Vegetable and Other Uses. Leaves used as a vegetable. Also has edible fruit. Grown as a village shade tree, outdoor room, for crop shade, and living fence. Bark used as fiber, latex used as well, leaves used as fodder.
Nutrition. Extremely high in iron and very high in calcium.
Growing Tips. Boukamkambou tolerates heavy pruning and coppicing. The aggressive root system can interfere with nearby paths, building foundations, and swimming pools.
Propagation. Usually grown from live stakes, but seed and air layering are also used.

Gou-Qi-Tou, Goji (*Lycium chinense*)
See Chapter 3.

Yuca, Cassava (*Manihot esculenta*)
This extremely important root crop is also grown for its edible leaves. The leaves are among the world's most widely produced and marketed tree leaf vegetables, grown in Brazil and sub-Saharan Africa. Leaves are high in cyanide and must be cooked for at least fifteen minutes. A multi-nutrient species for both traditional malnutrition and industrial diet deficiencies.
Family: Euphorbiaceae.
Names: Bengali: shimul ali. English: cassava, manioc, tapioca. French: manioc, cassave. German: maniok, bittre cassava, maniokstrauch. Hindi: tikhoors maravalli, karrapendalamu, tapioca, sakarkanda. Indonesian: ubi kayu, singkong, ketela pohon, kaspe, ubi jendral. Japanese: imanoka, kyassaba. Mandarin Chinese: shu shu, shên tzu, mu shu. Marathi: prochugaali chine, tapioca. Portuguese: mandioca, maniba. Russian: maniok s'edobnyj. Spanish: yuca, guacamote, mandioca, tapioca. Swahili: mhogo, kopa. Tamil: kuchi kizhangu, aal vallikkzhangu, maravalli. Telugu: karra pendalamu, koyaganasu gadda. Turkish: aci manyok, tapioca, yuka. Urdu: tikhoor maravali. Wú Chinese: shu shu.
Form: Evergreen or deciduous shrub.
Origin: Tropical Americas, likely domesticated in northern South America.

Figure 4.10. *Manihot esculenta* is a root crop of global importance but also among the most widely eaten tree leaves. Image Forest and Kim Starr, CC BY 2.0.

Climate and Soils: Tropical and subtropical lowlands, up to 1500 m. Rainfall from 500-6000 mm.
Vegetable and Other Uses. The leaves are especially widely consumed and marketed in Africa. The roots of course are one of the world's most widely grown and eaten carbohydrate foods, and the highest yielding of any starch crop.

Nutrition. Extremely high in Vitamins C and E, very high in iron, zinc, and Vitamin A, and high in fiber and calcium. A top ten species for Vitamins C and E.
Growing Tips. For dedicated leaf production, cuttings are planted much closer together then for root production. (Leaves can also be harvested from plants grown for the roots, though in a less intensive fashion.) While grown from six to twelve months as a root crop, for leaf production cassava can grow for a decade or more if the roots are unharvested (or with only some roots carefully excavated from the side). Many African growers have selected virus-infected plants to propagate, as their leaves are extra tender and delicious.
Propagation. Grown from live stakes just like cassava grown for the roots.

Nkweso, Tree Cassava (*Manihot carthaginensis subsp. glaziovii*)
This species is native to the tropical Americas and is a minor rubber crop around the world. In the Democratic Republic of Congo, one variety has been taken into cultivation as a vegetable. When compared to its more popular relative cassava, which is semi-woody, nkweso is a proper tree.
Family: Euphorbiaceae.
Names: English: tree cassava, Ceara rubber. French: Céara, caoutchoutier de Céaea. German: Cera-Mariok, Cerakautschukbaum. Kongo: nkweso, nsaki kausu. Mandarin Chinese: mu shu jiao. Portuguese: manicoba de ceara, mandioca brava. Spanish: caucho blanco, Cauchotero de Ceará. Swahili: mpira.
Form: A small tree.
Origin: Tropical Americas.
Climate and Soils: Tropical semi-arid and humid lowlands, with rainfall as low as 600mm. Tolerant of poor soils, and both wet and dry soils.
Vegetable and Other Uses. Leaves cooked. These should presumably be cooked for a long time before eating to remove toxic cyanide, as with cassava. Used for rubber production, including on a village scale for repair of bicycle inner tubes in the DRC.
Nutrition. Not available.
Growing Tips. Little information is available on growing this species as a vegetable. For rubber production it is planted in orchards.
Propagation. Grown from seed and cuttings.

Figure 4.11. Nkweso, a tropical American species, is usually grown as a rubber crop. However, growers in the in the Democratic Republic of Congo have selected a vegetable variety. Image Scamperdale, CC BY-NC 2.0.

Figure 4.12. The leaves of *Morinda citrifolia* are mild and tender. Image Scot Nelson, public domain.

Noni, Indian Mulberry (*Morinda citrifolia*)
Though it is primarily grown around the tropics for the medicinal fruit, noni is also grown for its edible leaves in Indonesia. A multi-nutrient species for both traditional malnutrition and industrial diet deficiencies. The leaves have similar texture to kale or collards, and a sweet and slightly bitter flavor. Noni is fast growing year-round.
Family: Rubiaceae
Names: Bengali: ach, al, bartundi, surangi. English: noni, Indian mulberry. French: bois douleur. Hindi: ach, al, bartundi, surangi. Indonesian: mengkudu, bengkudu, kudu. Japanese: yaeyama-aoki. Javanese: bentis, kemoodoo, koodoo, mengkoodoo, patjé. Madurese: koddho(k), kodhook. Malay: bengkadoo, mengkoodoo. Marathi: achi, al bartundi, surangi. Portuguese: pau-azeitona. Spanish: mora de la India. Sundanese: tjangkoodoo. Tamil: nuna, chayapattai. Telugu: mogali, maddi.
Form: Small evergreen tree.
Origin: Tropical Asia, New Guinea, Australia.

Climate and Soils: To 1500m. 700-4200 mm rainfall. Tropics and subtropics. Grows in sand dunes, urban soils, and other difficult sites. Noni is extremely drought tolerant. Damaged by frost but eventually resprouts.
Vegetable and Other Uses. Young leaves cooked, older leaves used as food wraps. Fruit has many medicinal uses and is edible though far from delicious to most people.
Nutrition. Leaves are extremely high in Vitamin A, very high in calcium, iron, and magnesium, and high in fiber and zinc. A top ten species for Vitamin A.
Growing Tips. Coppices well. Harvest by pinching off the top few centimers of each branch once the leaves are almost full sized. This encourages dense branching and abundant new tender leaves.
Propagation. Grown from seed.

Figure 4.13. Leaves, flowers, unripe edible pods, and mature pods of *Moringa oleifera*.
Image Eric Toensmeier, CC 3.0.

Moringa (*Moringa oleifera*)
Moringa is one of the few trees with edible leaves grown commercially for a global market, in this case for the dried leaf powder. The recent success of this tree vegetable provides evidence of the potential to increase production and consumption of the other species in this manual. The small size of the leaflets make harvest more labor-intensive than larger-leaved crops like chaya. Flavor of the raw leaves is very strong, resembling horseradish. Cooked leaves are milder. When the nutrient content of the edible flowers is also considered, this species is a multi-nutrient species for traditional malnutrition.
Family: Moringaceae
Names: Arabic: rawag, al-ban. Bengali: sajina, sohjna, sujina, dnata. English: drumstick tree, moringa, horseradish tree. French: moringa, acacia branca, ben ailée, néverdié. German: Meerrettichbam, Pferderettichbaum. Gujarati: saragwaani, shing, saragwo. Hindi: soanjna, suhujna, sajan. Indonesian: kelor, kelentang, kelintang, merunggai, remunggal. Japanese: wasabi-no-ki. Malayalam: muringakka. Marathi: shevgyachya, shenga. Portuguese: moringa, quiabo-de-quina, moringueiro. Spanish: moringa, paraíso blanco, maranga. Swahili: mzunze, mronge, mlonge. Tamil: morunga, morungai, moringa, murungakkai. Telugu: mulaga, kaya, mulakada. Urdu: sahajna.
Form: Small to medium deciduous tree.
Origin: South Asia.
Climate and Soils: Tropics and subtropics (killed back by frost but reprouting vigorously). Typically a lowland species but reported to grow as high as 2000m in some locations. Rainfall as low as 500mm but prefers higher.
Vegetable and Other Uses. Young leaves with a strong horseradish flavor, milder when cooked. Also grown for the edible flowers, tender edible pods, older pods with young seeds inside, the seeds, seed oil, spicy roots, livestock fodder, as a living fence, and more. Seeds can be used as a flocculant to purify water. In India and Pakistan where it is native, moringa is mostly grown for the pods rather than the leaves, though elsewhere the leaves are the main crop.
Nutrition. Very high in iron, magnesium, zinc, and Vitamin C, and high in Vitamin E. The flowers and pods and also highly nutritious. A top ten species for Vitamin C.
Growing Tips. For leaf production moringa is often grown in intensive coppice systems, sometimes in hedgerows.
Propagation. Grown from live stakes and from seed.

Saffara, African Moringa (*Moringa stenopetala*)
Widely grown and marketed in Ethiopia, where it is regularly consumed by five million people. The larger leaflets make for much easier harvest and processing than *M. oleifera.* Especially valuable as the leaves are of very good flavor during the dry season. A multi-nutrient species for industrial diet deficiencies.
Family: Moringaceae
Names: Amharic: haleko, shifa, shifara, aleko. English: African moringa, cabbage tree. French: moringa éthiopien. Konso: saffara, salchada, telchada.
Form: Small to medium deciduous tree.
Origin: Native to Ethiopia and Kenya. Extinct in the wild in Ethiopia and nearly so in Kenya.
Climate and Soils: This species prospers in drier climates, and higher elevations, than *M. oleifera.* Tropics and subtropics, lowlands and highlands. 400-1650 m elevation. Rainfall 500-2400 mm. Tolerates light frosts. In subtropical climates it is killed back by cold but resprouts readily.
Vegetable and Other Uses. Primarily grown for the leaves. Also grown as fodder. Seeds can be used to purify water.

Figure 4.14. *Moringa stenopetala,* one of many unique crops developed by Ethiopian farmers and gardeners. Image Scamperdale, CC BY-NC.

Nutrition. Extremely high in fiber and calcium, very high in iron. A top ten species for fiber and calcium.
Growing System: Some Ethiopian growers pollard or lop plants every five years, but this species can also be coppiced annually.
Propagation. Quite easily grown from seed. African moringa is mostly grown from seed as cuttings and live stakes develop shallow root systems.

Hong Sang, Mulberry (*Morus alba*)
See Chapter 3.

Figure 4.15. *Opuntia ficus-indica* with hoop frames for commercial winter production, Mexico. Image courtesy Gerardo Ruiz Smith.

Nopale Cactus, Prickly Pear (*Opuntia atropes, O. cochenillifera, O. ficus-indica, O. leuchtricha, O. streptacantha*)
A number of closely-related cactus species are cultivated as vegetables. It is technically the pads (cladodes) rather than the leaves that are consumed. Flavor is mild and similar to green beans, and texture is somewhat mucilaginous like okra. *O. ficus indica* is an important vegetable in Mexico, where there are 20,000 ha in production. The other species listed above are also cultivated at a smaller scale. Pads can be stored for over two weeks after harvest without refrigeration.
Family: Cactaceae
Names:

- ***O. atropes:*** Spanish: nopal.
- ***O. cochenillifera:*** Arabic: hendi, seurti, nowara hindia. English: cochineal cactus. French: cochenillier, raquette espagnole. German: Cochenille-Feigenkaktus. Other Indigenous Mexican names: bi-aa, bi-yaa, nochestli. Nahuatl: noch-eztli, tlalnpal. Portuguese: cacto-de-cochonilha. Spanish: nopal chamacuero, nopal de cochinilla, pak'an.

- ***O. ficus-indica:*** English: nopale cactus, prickly pear. French: chardon d'Indie, figuier de'Inde. German: feigenkaktus, opuntie. Indonesian: duri gambas, duri tiongkok. Mandarin Chinese: xian ren zhang. Nahuatl: nopale, tenochtli. Portuguese: figueira da Índia, piteira. Spanish: nopal, nopal de castilla. Tamil: sappaatthukkalli. Telugu: naagajemudu. Turkish: frenk inciri. Urdu: kantadar naspati. Wú Chinese: xian ren zhang.
- ***O. leuchotricha:*** Spanish: nopal chaveño, nopal duraznillo.
- ***O. streptacantha:*** Spanish: nopal cardón.

Form: Shrubby or treelike cactus.
Origin: Mesoamerica. Both *O. cochellinifera* and *O. ficus-indica* are listed in the Global Invasive Species Database.
Climate and Soils: Most of these species are tropical or subtropical, which is also true of most spineless clones of *O. ficus-indica.* However, some varieties of *O. ficus-indica* tolerate more cold, including "1233" and the Argentinian hybrids "42," "46," "80," "83," and "150." The U.S. native *O. ellisiana* spineless variety "1364" is hardy to zone 7 (it would seem that a bit more creativity in naming hardy spineless cacti is in order). Some spineless varieties available in the nursery trade are surprisingly cold hardy as well. Highlands up to 2600 m. Rainfall 150 to 2000 mm, but vulnerable to disease in wetter areas.
Vegetable and Other Uses. The pads of spineless varieties are consumed raw and cooked. Also widely grown for the fruit and as a fodder species.
Nutrition. *O. ficus-indica* pads have no nutrients ranked higher than medium, a situation actually quite unusual among tree vegetables. *N. cochenillifera* is very high in fiber and iron.
Growing Tips. Usually grown as a hedgerow or coppiced.
Propagation. Very easily grown from the pads. Age them several weeks in shade, and then bury halfway in the soil. In sandy soils this aging may not be necessary.

Figure 4.16. *Premna tomentosa* is a leaf crop in India.
Image Sidarth Machado, CC BY-NC 2.0.

Gohara (*Premna tomentosa*)
Grown as a vegetable in northeastern India. Formerly *P. latifolia.*
Family: Lamiaceae
Names: Assamese: gejeru, gonderi, gunaru. Bengali: gohara. Hindi: bakarcha, basota, jhatela. Indonesian: bulang. Marathi: chambara. Tamil: erunaimunnai, cummotakam. Telugu: nelli, peddanellakure.
Form: Medium tree.
Origin: South Asia, Southeast Asia, Australia, Pacific Islands.
Climate and Soils: Lowland tropics to 800m elevation. Rainfall from 870-1270mm.
Vegetable and Other Uses. Young leaves cooked. Also used for timber and medicine.
Nutrition. Unavailable.
Growing Tips. Coppices well.
Propagation. Grown from rooted cuttings and by digging suckers.

Bluegrey acacia (*Senegalia caesia*)
Grown as a vegetable in Southeast Asia and Yunnan, China. Formerly known as *Acacia caesia*.
Family: Fabaceae
Names: English: bluegrey acacia, incha, palinja. Hindi: kelle-doukha, aila. Malay: akar kayu manis, akar manis, kupoh. Marathi: chilari, chilhar. Tamil: kari indu, vellintu. Telugu: konda korintha, yerra cheeki.
Form: A small tree or large shrub, which can also climb. Quite spiny.
Origin: Tropical Asia
Climate and Soils: *S. caesia* can be found in the dry subtropics from 200- 2500 m elevation.
Vegetable and Other Uses. Cooked leaves. Has medicinal uses including the bark is used to kill lice.
Nutrition. *S. caesia* is extremely high in iron and high in zinc.

Figure 4.17. *Senegalia caesia* is a nitrogen-fixing tree vegetable.
Image Forestowlet, CCO 1.0.

Growing Tips. This species fixes nitrogen. In soils where legumes have been absent for a long time it should be inoculated with cowpea inoculant or soil from inoculated *Senegalia* species. It can be rather weedy and can smother adjacent trees.
Propagation. Most acacias can be grown from seed. Pour boiling water onto seeds, and soak twelve to twenty-four hours. If not swelling after that time, cut the seed a bit with a knife and soak again.

Ki Lek Luang, Kassod tree (*Senna siamea)*
Cultivated in Southeast Asia for its bitter-tasting leaves.
Family: Fabaceae
Names: English: kassod tree, ironwood. French: bois perdrix. Hindi: kassod, seemia. Japanese: tagaya-son-no-ki. Mandarin Chinese: guo mai xi li. Marathi: kassod. Portuguese: cássia-siamesa. Spanish: flamboyán amarillo. Tamil: chelumalarkkonrai, manjal konrai, manje-konne. Telugu: kurumbi, sima tengedu. Thai: ki lek luang, ki lek yai.
Form: Medium evergreen tree.
Origin: Southeast Asia.
Climate and Soils: Lowlands up to 1300 m. Rainfall from 500-2000 mm, dry season as long as eight months.
Vegetable and Other Uses. Young leaves, flowers, and young pods eaten. A widely-grown multipurpose agroforestry species used for windbreaks, crop shade, windbreak, living fence, and alley cropping. Also used for tannins, timber, charcoal and firewood.
Nutrition. Extremely high in fiber, iron, and Vitamin C.
Growing Tips. Coppices well. A non-nitrogen fixing legume.
Propagation. Pour boiling water over seed and soak for twelve to twenty-four hours, or scarify by nicking the seed coat. Somewhat slow to germinate.

Figure 4.18. *Senna siamea,* a strong-flavored leaf crop that is popular in Southeast Asia. Image Reniusplace, CC BY-SA 3.0.

Katuk (*Sauropus androgynous*)
See Chapter 5.

Papelillo (*Sinclairia sublobata*)
Cultivated as a vegetable in Mexico and Central America. Said to have a rich flavor, and used in soups, pupusas (stuffed tortillas), and other dishes.
Family: Solanaceae
Names: Spanish: quilete, papelillo, San Nicolás, tampupo
Form: Shrub or small tree.
Origin: Central America, southern Mexico.
Climate and Soils: Semiarid and humid tropics, sun to part shade. 500-1400 m.
Vegetable and Other Uses. Leaves cooked as a vegetable. Also used as a living fence.
Nutrition. Data unavailable.
Growing Tips. Coppices well. Would likely be suited to hedgerow management given its use as a living fence.
Propagation: Grown from seed and live stakes.

Ikan, Potato Tree (*Solanum erianthum*)
Ikan is grown as a vegetable by the Idatcha people of Benin for the leaves and young fruit. It is also sold in markets there. This species is native to tropical Americas but has naturalized in Africa where it has been taken into cultivation as a vegetable. Also grown for its edible fruits (used as a vegetable) in tropical Asia. Like many members of this genus, the leaves contain toxic solanine and perhaps other poisonous alkaloids and should be consumed with caution by people outside of Benin. In fact, be warned that there are reports that the leaves can cause miscarriage.
Family: Solanaceae.
Names: English: potato tree, tobacco tree. French: amourette marron. Idatcha: ikan.

Figure 4.19. *Solanum erianthum,* native to the Americas and cultivated in Benin. Image Dinesh Valke, CC BY-SA 2.0.

Form: Small evergreen tree.
Origin: Native to the tropical Americas and now a pantropical weed.
Climate and Soils: Up to 1,500 m elevation in sun to partial shade.
Vegetable and Other Uses. The berries are reported as toxic but are cooked and eaten in tropical Asia.
Nutrition. Data are unavailable.
Growing Tips. Grown as a shade tree for coffee.
Propagation. Propagated with seed.

Xiang Zhon, Chinese Toon (*Toona sinensis*)
See Chapter 3.

Figure 4.20. *Trichostigma octandrum,* an important leaf crop of Haiti. Image Anonyme973, CC BY-SA 4.0.

Liann Panye, Haitian Basket Vine (*Trichostigma octandrum)*
Liann panye is native to much of the tropical Americas. In Haiti it is grown as a vegetable and has a reputation for being a very healthy food. It can grow as either a shrub or a vine.
Family: Petiveriaceae
Names: English: Haitian basket vine. French: liane pannier, liane a barques. Haitian Creole: liann panye. Spanish: bejuco canesta, sotacaballo, pabello.
Form: Somewhat vining shrub.
Origin: Tropical Americas.
Climate and Soils: Tropical and subtropical, humid and semi-arid. Sun to full shade, perhaps even growing better in shade.
Vegetable and Other Uses. Young leaves cooked. Also used in basketry.
Nutrition. Unavailable.
Growing Tips. Coppices well and maintains a shrubby form with this maintenance.
Propagation. Grown from seed, cuttings, and layering.

Afetewa, Black Plum (*Vitex doniana*)
Cultivated for both its leaves and fruits in Ghana, grown for its fruit (with edible leaves appreciated as well) in much of Africa, and often left in place when clearing land throughout West Africa. Leaves from wild trees are marketed in Benin and elsewhere. One of the "chocolate berries" that have been identified as priorities for domestication as nutritious fruits. The leaves are marketed locally. In some places, like Benin, widespread harvest of wild trees for market sales is endangering the wild populations, making the tree a good candidate for broader cultivation.
Family: Verbenaceae
Names: Akan: abisowa, abisa, afua, ofoa, afetewa, afowa, samanibir, narenga. English: black plum. Swahili: mfudu, mfuru, mfuu.
Form: A small to medium-sized deciduous tree.
Origin: Widespread across Sub-Saharan Africa
Climate and Soils: Humid and semi-arid areas. Up to 2000 m elevation, and rainfall from 750-2000 mm. Prefers rich soils.
Vegetable and Other Uses. In addition to its edible leaves, this species is also cultivated for its edible fruit. In fact it is considered perhaps the best of the "chocolate berries" in its genus. Also valued for its timber and medicinal uses. It stays green well into the dry season, making it valuable as forage and perhaps as a dry-season vegetable as well. Leaves should be cooked as they contain traces of cyanide, much like chaya and cassava leaves but with lower levels.
Nutrition. The leaves are extremely high in iron and Vitamin E. A top ten species for iron and Vitamin E.
Growing Tips. Coppices readily. Grown from suckers and cuttings. To grow from seed, pierce the hard seed coat and then soak in water for twenty-four hours before planting.

Figure 4.21. *Vitex doniana,* grown for both its fruit and its leaves. Image Bamba Tubaab, CC BY-SA 4.0.

CHAPTER FIVE

Humid Tropics and Subtropics

The humid tropics are well-known for their remarkable biodiversity. This holds true for cultivated woody plants with edible leaves; our study identified one hundred and three in total. For this publication, lowlands are defined as below 1500m elevation and highlands are defined as above 1500 m. Subtropical species are suited to habitats with some frost, corresponding to USDA Zone 9. The note about "frost coppicing" in the introduction to Chapter 4 applies here as well.

Southeast Asia is clearly the world leader in humid tropical tree vegetable cultivation with a remarkable forty-nine species. South Asia, Mesoamerica, and Sub-Saharan Africa each cultivate eighteen species. New Guinea grows twelve native species, Pacific Islands nine, South America and temperate Asia nine each. It seems likely that additional species are being grown in sub-Saharan Africa and Amazonia, but did not turn up in our literature search.

Aibika, Edible Hibiscus (*Abelmoschus manihot)*
A popular vegetable in New Guinea, Southeast Asia, and the Pacific. Notable for its mild flavor. Aibika can be eaten raw, unlike many tree vegetables. It makes an excellent food wrap. Texture is mildly mucilaginous like its cousin okra.
Family: Malvaceae
Names: Bauan: bele, mbele, vauvau ni viti. Bislama: aelan cabis. English: edible hibiscus, sunset hibiscus, slippery cabbage. French: ketmie á feuilles de manioc, bréde kanaque, choux gluant. German: maniok-eibisch. Hindi: jangli bhindi. Hiri Motu: aurao. Indonesian: gedi, degi, kopi arab, bunga dapros gedil. Japanese: tororo-aoi. Mandarin Chinese: huang shu kui. Marathi: jangali bhendi, ranbhendo. Portuguese: guiabo, quiabeiro. Solomon Islands Pidgin: aelan kapis, neka. Spanish: santa elena. Tok Pisin: aibika. Turkish: miskotu, mani ok. Wú Chinese: huang shu kui.
Form: Shrub or small tree.
Origin: South and Southeast Asia, Australia, New Guinea and Pacific.
Climate and Soils: Humid tropics and subtropics from sea level to 500 m, occasionally to 1700 m. Rainfall 1000 mm or more with minimal or no dry season.
Vegetable and Other Uses. Mostly grown for the young leaves, but the flowerbuds are also eaten like the related okra. Used medicinally and in papermaking, and oil is pressed from the seeds. In many places grown as an annual because it succumbs to disease after the first year, but a proper semi-woody perennial in other regions.
Nutrition. Aibika is very high in calcium, iron, zinc, and Vitamin E, and high in Vitamin C.
Growing Tips. Coppiced and grown as a hedgerow.
Propagation. Grown from seed and cuttings.

Figure 5.1. *Abelmoschus manihot,* a mild and delicious relative of okra. Image Eric Toensmeier, CC 3.0.

Sepang (*Acalypha caturus*)
The cooked leaves and shoots are eaten throughout Southeast Asia where it is noted for its sweet taste, and cultivated in Indoensia and Malaysia.
Family: Euphorbiaceae
Names: Malay: sepang Sulawesi: kayu in cios.

Form: Shrub or small tree.
Origin: Southeast Asia and New Guinea.
Climate and Soils: Up to 1400 m elevation.
Vegetable and Other Uses. Cooked leaves.
Nutrition. Data unavailable.
Growing Tips. Details are unavailable, but some ornamental *Acalypha* species are used in hedges. Grown in agroforestry systems including shade coffee.
Propagation. Details on this species are unavailable, but many *Acalypha* species are propagated with cuttings.

Baobab (*Adansonia digitata*)
See Chapter 4.

Durep, Japanese Angelica Tree (*Aralia elata*)
See Chapter 3

Neem (*Azadirachta indica*)
See Chapter 4.

Figure 5.2. *Bauhinia purpurea,* a tree vegetable with many edible parts. Image Thamizhpparithi Maari, CC BY-SA 3.0.

Siao Wan, Orchid Tree (*Bauhinia purpurea)*
The orchid tree is cultivated as a leaf vegetable in Thailand. In India, where it is known as kachnar, it is primarily grown for the edible flowerbuds. Many other species of orchid tree are important vegetables in Asia, notably *B. variegata*, but it is not clear that they are cultivated specifically for their edible leaves. *Bauhinia purpurea* is widely grown as an ornamental throughout the tropics.
Family: Fabaceae
Names: Bengali: deva-kanchan, koiral. English: camel's foot. Hindi: khairwal, kaniar. Indonesian: kembang kupu-kupu. Japanese: murasaki-soshin-ka. Mandarin Chinese: yang ti jia. Marathi: rakta chandan, atmatti. Punjabi: karalli, kara, khairwal. Spanish: pata de cabra, pie de cabra. Tamil: nilattiruvatti, acanomantarai. Thai: ka-hoe, chongkho, sa-pe-si, siao dok daeng, siao wan. Telugu: arow, bodanta.
Form: Small to medium deciduous trees with beautiful flowers, often pink, resembling orchids.
Origin: South and Southeast Asia.
Climate and Soils: Lowlands and highlands up to 2000 m, tropics and subtropics. Rainfall 1000-5000 mm. Prefers well-drained soils but performs well in compacted urban soils.
Vegetable and Other Uses. In addition to the leaves, the flower, pods, and unripe seeds of *B. purpurea* are also used as vegetables. A very popular ornamental throughout the tropics, often seen as a street tree.
Nutrition. Leaves of *B. purpurea* are extremely high in iron and very high in fiber.
Growing Tips. Coppices well and can also be grown as a hedge. Though legumes, *Bauhinia* species do not fix nitrogen.
Propagation. Grown from seed, layering, and softwood cuttings.

Gandaria (*Bouea macrophylla*)
Gandaria is often cultivated for its fruit, but in Java has been cultivated commercially for its leaves for some time. Young leaves are sometimes colored white, lavender, or violet. Flavor of the leaves is mild.
Family: Anacardiaceae
Names: English: gardaria, kadongan. Indonesian: gandaria, gundangan, kundangan. Javanese: gandareea. Malay: gandareea, kundangan, kundang, setar. Sundanese: djataké, gandareea. Tagalog: gandaria.
Form: A large evergreen tree.
Origin: Southeast Asia.
Climate and Soils: Sea level to 800 m elevation. Humid tropical lowlands. Light soils preferred but also found in peatlands.
Vegetable and Other Uses. Edible young leaves eaten raw or cooked. Fruit known as "plum mango" is eaten raw (ripe) or cooked (unripe or ripe). A minor timber species as well.
Nutrition. Information on the leaves not available.
Growing Tips. Cultivated from seed and air layers. It is not reported to coppice.

Figure 5.3. *Bouea macrophylla,* usually a fruit crop but also grown for its leaves in Indonesia.
Image W.A. Djatmiko, CC BY-SA 3.0.

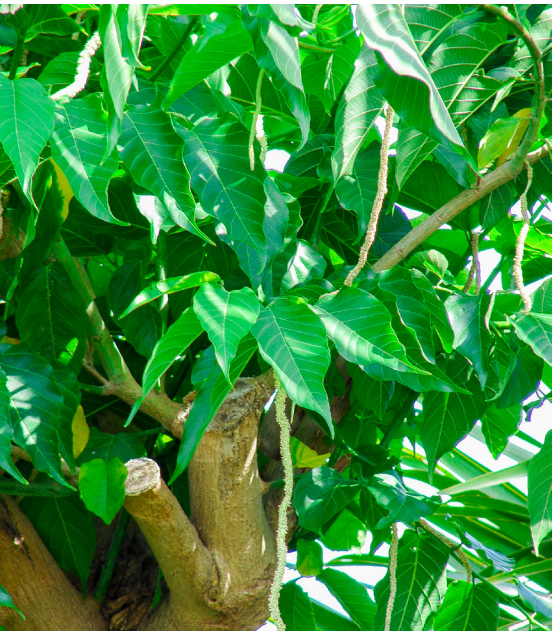


Image 5.4. *Broussonetia luzonica* resprouting well from lopping.
Image Forest and Kim Starr, CC BY 3.0 US.

Himbabao (*Broussonetia luzonica*)
Grown as a vegetable in the Philippines.
Family: Moraceae
Names: Bisaya: balong-kadios. Ilocano: baeg. Tagalog: himbabao, babayan.
Form: Medium to large deciduous tree.
Origin: Native to the Philippines.
Climate and Soils: Growing up to 1100 m. Humid tropics.
Vegetable and Other Uses. Grown for the edible leaves and flowers. Bark used for fiber, wood used for furniture and other purposes.
Nutrition. Extremely high in iron and very high in calcium.
Growing Tips. Coppices well.
Propagation. Grows from seed and cuttings.

Lapeht, Tea (*Camellia sinensis*)
See Chapter 3.

Kradone, Kumbha (*Careya arborea*)
See Chapter 4.

Col deMonte (*Carica monoica*)
This Andean relative of papaya is grown not only for the fruits but also the edible leaves. The leaves of ordinary papaya (*C. papaya*) are also cooked but are very bitter. *Carica monoica* was formerly knowns as *Vasconcellea monoica.*
Family: Caricaceae
Names: Spanish: col de montaña, col de monte, peladera, chamburo, yumbo papaya, toronche.
Form: Small tree. Bushier than common papayas.
Origin: Lower-elevation Andes of South America.
Climate and Soils: 500-2000m. Prefers partial shade.
Vegetable and Other Uses. The leaves are cooked, as are the seedlings. It is said to be used like cabbage, and its Spanish names refer to this. Ripe fruit is eaten (though not very flavorful), and unripe fruit cooked as a vegetable.
Nutrition. Data not available.
Growing Tips. This species is grown and/or welcomed in Andean hedges and homegardens.
Propagation. Grown from seed, rather slow, taking thirty days to germinate.

Figure 5.5. *Carica monoica,* a papaya grown for its edible leaves.
Image Steffen Zahn, CC BY 2.0.

Figure 5.6. *Carpolobia lutea,* one of a number species of tree leaves grown in the Democratic Republic of Congo.

Agbá (*Carpolobia lutea*)
Cultivated as a leaf crop in the Congo region.
Family: Polygalaceae
Names: Igbo: agbá, aziza, uzuza. Yoruba: orere, ósún, ósúnsún.
Form: Shrub or small tree.
Origin: West Africa
Climate and Soils: Up to 400 m. A shade-tolerant forest understory tree.
Vegetable and Other Uses. In addition to the edible leaves, the fruit is also edible.
Nutrition. Data unavailable.
Growing Tips. We were unable to find information.
Propagation. We were unable to find information.

Sumaúma, Ceiba (*Ceiba pentandra*)
See Chapter 4.

Mofungo-Gigante (*Chamissoa altissima*)
See Chapter 4.

Salang (*Claoxylon indicum, C. longifolium*)
Grown in tropical Asia for the young leaves and shoots. When cooked, it is also used as an edible food wrap.
Family: Euphorbiaceae
Names:
***C. indicum* :**Hindi: salang Hindi. Javanese: bleketoopook, ketoopook, ketoopook alas. Madurese: katerbih, katerbik, katerbis. Malay: setampoo, tetoopook. Sundanese: talingkoop. Thai: ngyn peungkhao. Vietnamese: chinh hoí, loc ma, mo trang.
C. longifolium: Hindi: salang sayur. Javanese: ketoopook, kooyam. Malay: sayor salang. Sundanese: keeléat. Thai: phakwan-chang. Vietnamese: boof lost las dafi, lawjc ma.
Form: Shrubs or small trees.
Origin: Tropical Asia, New Guinea
Climate and Soils: *C. longifolium* is found between 200-2000 m. *C. indicum* is found from 100-850 m.
Vegetable and Other Uses. Both species are noted as having laxative properties which suggests starting with small quantities if you are unfamiliar with its vegetable use.
Nutrition. Data unavailable.
Growing Tips. We were unable to find information.
Propagation. Grown easily from cuttings. Also grown from seed.

Nangyaempa, Pagoda Flower (*Clerodendrum glandulosum)*
Cultivated in kitchen gardens by the Adi people in Northeast India. Also occasionally grown in gardens in Thailand and northern Myanmar. Leaves are bitter, usaully blanched and eaten dipped into chili sauces. Formerly *C. colebrookianum.*
Family: Verbenaceae
Names: Assamese: dhopat-tita, nephaphu. English: pagoda flower. Thai: nangyaempa.
Form: Evergreen shrub or small tree to 5 m.
Origin: South and East Asia.
Climate and Soils: 500-2000 m. Sun to part shade. Tropics and subtropics.
Vegetable and Other Uses. Young leaves and shoots, bitter.
Nutrition. Extremely high in zinc, very high in iron, and high in fiber and magnesium.
Growing Tips. Many species in this genus coppice well.
Propagation. Grown from seed, cuttings, root cuttings, and digging of suckers.

Figure 5.7. *Clerodendrum glandulosum* in a Thai home garden. Image courtesy Rick Burnette.

Chaya (*Cnidoscolus aconitifolius*)
See Chapter 4.

Chipilín (*Crotalaria longirostrata*)
The leaves of the chipilín shrub are quite popular in parts of Mexico and Central America, including for its use in tamales. The leaves are often exported to immigrants living in the United States, and chipilin is also grown as an annual in temperate parts of the United States with large Central American populations. Like chipilín, the leaves are said to produce a mild sleepiness not unlike turkey. Its flavor is rich and similar to spinach. Many related species are toxic, but a number of other *Crotalaria* species are cultivated in Africa and the Americas (none of these other crops are woody perennials though).
Family: Fabaceae
Names: English: chipilín. Indigenous Mesoamerican Names: al-a-ju, chepil, chipila, chipilín, tzaz-chop, vichi. Spanish: cascabel, chipilín, chipile, garbancillo, quiebraplato, tronador.
Form: Deciduous shrub.
Origin: Mesoamerica.
Climate and Soils: 1000-2200 m.
Vegetable and Other Uses. Leaves are eaten cooked. The flowers and flowerbuds are also used as vegetables. Seeds are very toxic.
Nutrition. Extremely high in iron, very high in calcium, high in Vitamin C.
Growing Tips. Coppiced and grown as a hedge. A nitrogen-fixing legume, and should be inoculated with cowpea inoculant if needed.
Propagation. Grown from seed.

Figure 5.8. *Crotalaria longirostrata* in the understory of a multistrata agroforestry system in Guatemala. Image Eric Toensmeier, CC 3.0.

Figure 5.9. *Erythrina berteroana* sprouting from the base of the trunk.
Image Forest and Kim Starr, CC BY 3.0.

Three-Leaved Eleuthro (*Eleutherococcus trifoliatus*)
See Chapter 3.

Pito (*Erythrina berteroana*)
The young leaves and flower buds are eaten in Central America, and exported to Guatemalan and Salvadoran immigrants in the United States. Like chipilín, this species is said to cause mild sleepiness like eating turkey.
Family: Fabaceae
Names: Spanish: pito, bucare, machete, miche, peronio. Maya names: miche, tzite.
Form: Medium deciduous tree.
Origin: Central America, and perhaps adjacent South America and the Caribbean.
Climate and Soils: Tropics and subtropics, 1000-4000mm rainfall, elevation to 2000m.
Vegetable and Other Uses. Young leaves and flowerbuds used as vegetables. Used for many agroforestry purposes including alley cropping, living fences, crop shade, living trellises, livestock fodder, and windbreaks.
Nutrition. Very high in iron.
Growing Tips. Coppices well. A nitrogen-fixing legume. If inoculant is needed use cowpea *Bradyrhizobium.*
Propagation. Grown from live stakes and from seed.

Pito, Coral Bean (*Erythrina americana, E. mexicana*)
See Chapter 4.

Figure 5.10. *Erythrococca atrovirens,* an African relative of cassava and chaya. Image Scamperdale, CC BY-NC.

Bindi (*Erythrococca atrovirens*)
Cultivated as a leaf vegetable in the Democratic Republic of Congo.
Family: Euphorbiaceae
Names: Congo regional names (language uncertain): bindi, dikili, mascha, ntenteke, nzekenzeke, nsusa. English: dark green erythrococca.
Form: Shrub or small tree, sometimes climbing.
Origin: Tropical Africa.
Climate and Soils: 1000-2100 m.
Vegetable and Other Uses. Edible leaves.
Nutrition. Data unavailable.
Growing Tips. Information unavailable.
Propagation. Grown from seed.

New Guinea Vegetable Figs (*Ficus copiosa, F. dammaropsis, F. wassa*)
Throughout tropical Asia, New Guinea, and the western Pacific, the leaves of many fig species are eaten. New Guinea, which seems to be the world epicenter of edible fig leaf cultivation and consumption, is home to at least three cultivated species. Many more are probably grown in gardens. Some are sold in markets as well.
Family: Moraceae
Names:

- ***F. copiosa:*** English: Plentiful fig. Tok Pisin: kumu musong.
- ***F. dammaropsis:*** English: dinner-plate fig, highlands kapiak. Tok Pisin: hailans kapiak.

Form: Small to medium evergreen trees.
Origin: Southeast Asia, New Guinea, Australia, western Pacific.
Climate and Soils: *F. copiosa:* humid tropics up to 1800 m. *F. dammaropsis:* humid tropics and subtropics, 900-2700 m. *F. wassa:* Humid tropics, elevations under 300 m.

Figure 5.11. The enormous leaves of *Ficus dammaropsis* (at center). Image Kahuroa, public domain.

Vegetable and Other Uses. Young leaves of all three species eaten cooked. Young fruits of *F. dammaropsis* and *F. wassa* are cooked along with the leaves. Older leaves used as food wraps. The leaves of *F. dammaropsis* are enormous, up to one meter long, and come in a range of colors from red through yellow and green. The large leaf midribs of this species are especially valued as food. Some species also used for fiber, as fodder, and other uses.
Nutrition. *F. copiosa* leaves are extremely high in calcium and very high in magnesium and zinc. It is a top ten species for calcium.

Figure 5.12. *Ficus racemosa,* an important vegetable fig of Southeast Asia. Image courtesy Rick Burnette.

Growing Tips. Some, like *F. copiosa,* are grown in hedges for leaf production.
Propagation. Most are propagated by cuttings, air layering, and seed. *F. dammaropsis* will not grow from cuttings.

Southeast Asian Vegetable Figs (*F. pseudopalma, F. racemosa, F. superba, F. virens*)
A great many species of fig are used for their edible leaves in Southeast Asia. Of those, these four are confirmed to be cultivated, but surely many more are as well (*F. lacor* is also grown as a vegetable there but is treated in the tropical drylands section). In Thailand the sour leaves of *F. virens* are of great importance because its season of harvest is in the driest part of the year when vegetables are scarce. Useful

plant expert Crafton Clift believes that *F. pseudopalmata* is the most delicious leafy green in the world.
Family: Moraceae
Names:

- *F. pseudopalma:* Bicol: lubi-lubi. English: palm fig.
- *F. racemosa:* Arabic: jammaaiz, tinul-ahmaq. Bengali: udumbara. English: red-shoot fig, cluster fig. Hindi: gular, umar, jagya dumur. Indonesian: crattock. Mandarin Chinese: yu dan bo luo. Marathi: udumbar, umbar. Portuguese: rumbodo. Tamil: atti, nalla atthi, anai, utumparam, malaiyin munivan. Telugu: atti, bodda, brahmamamidi. Thai: maduaklieng. Urdu: dumar, gular.
- *F. superba:* English: sea fig. Thai: krai, sai-liap. Vietnamese: sung ki[ee]u.
- *F. virens:* English: spotted white fig. Hindi: kahimal, keol, pilkhan, pakri. Javanese: booloo bras, boolo tambi, eepé, eepih, woonoot, woonoot banjoo. Madurese: ampooloo, boonoot. Marathi: bassari, gandhaumbara. Sundanese: bonoot. Tamil: ichchi, kurugatti, malai-ichichi. Telugu: badijuvvi, jatti. Thai: phak huat.

Form: *F. racemosa* is medium to large deciduous tree. *F. superba* is a medium deciduous tree, sometimes growing as a strangler fig. *F. virens* is a very large strangler fig.
Origin:

- *F. pseudopalma:* Southeast Asia.
- *F. racemosa:* Tropical Asia, New Guinea, Australia.
- *F. superba:* Southern Japan and subtropical China and Southeast Asia.
- *F. virens:* Tropical Asia, New Guinea, Australia.

Climate and Soils:

- *F. pseudopalma.* Lowlands.
- *F. racemosa.* Tropics and subtropics, to 1700m.
- *F. superba:* Subtropics and tropics, very low elevations, coastal.
- *F. virens*: From 300-2700m in elevation.

Vegetable and Other Uses. Cooked young leaves of all three species, with *F. pseudopalma* and *F. virens* also eaten raw. Fruits of *F. racemosa* are edible. Leaves of most of these species are also used as fodder.
Nutrition. Data not available.
Growing Tips. *F. racemosa* coppices but regrows slowly. In Indian fodder production branches are lopped repeatedly instead, and perhaps this technique is more appropriate for vegetable use as well.
Propagation. Grown from the tiny seeds, air layers, or more commonly from cuttings.

Cluster Fig (*Ficus lacor*)
See Chapter 4.

Boukamkambou (*Ficus thonningii*)
See Chapter 4.

Só Dó (*Glochidion rubrum*)
Só dó is grown as a leaf vegetable in Southeast Asia. Related to the popular tree vegetable katuk.
Family: Phyllanthaceae
Names: Malay: gambiran, senkam, tetimah, menyam. Tagalog: bagnang-pula. Thai: chum set, khat na. Vietnamese: só dó.
Form: Evergreen shrub or small tree.
Origin: Southeast Asia.
Climate and Soils: 0-2100 m.
Vegetable and Other Uses. Leaves and shoots are eaten.
Nutrition. Not available.
Growing Tips. Grown as a hedge and living fence.
Propagation. Grown from seed.

Figure 5.13. *Glochidion rubrum,* a leaf vegetable similar to the related *Sauropus androgynus.* Image 石川 Shihchuan, CC BY-SA 2.0.

Figure 5.14. Seedling trees of *Gmelina arborea*, a famous timber tree also grown as a vegetable. Image Obsidian Soul, CC BY-SA 3.0.

Gumar, Goomar Teak (*Gmelina arborea*)
This species is a very widely grown timber and agroforestry species around the tropics. In its homeland of India, it is also cultivated as a vegetable for the tender young leaves.
Family: Lamiaceae
Names: Bengali: gamar, gambhari. English: goomar teak. French: gmelina, peuplier d'Afrique. German: Gumar-Teak. Hindi: gumbar, bhadraparni, gamhar. Mandarin Chinese: yúnnán shí zí. Marathi: shivan, thorshivani, shewan. Portuguese: gamelina. Spanish: melina, gamhar. Tamil: kumalaa, kumutai, kumpal, peru-n-kumil, gumadi, umi, kattanam, kumalaamaram. Telugu: pedda gumudu teku, gumartek, gummadi. West Bengali: gumar.
Form: Full-sized, deciduous tree (evergreen in some cases).
Origin: Tropical South Asia.
Climate and Soils: Up to 1400, occasionally 2100 m. Tropics and subtropics, rainfall from 750-4500 mm.
Vegetable and Other Uses. Young leaves used as a vegetable in rural areas in India. An important global timber plantation species. Flowers are eaten as is the bittersweet fruit. Widely used in many agroforestry systems throughout the tropics.
Nutrition. Data unavailable.
Growing Tips. Coppices well and grows very quickly, and also grown as a hedge.
Propagation. Grown from seed. Fresh seed is best. Can also be grown from cuttings using rooting hormones and misting.

Bago, Spinach Jointfir (*Gnetum gnemon)*
Spinach Jointfir is an important leaf vegetable in Thailand, Papua New Guinea, the Philippines, and many Pacific islands. Many people consider this species to be a vegetable of outstanding flavor, with leaves sweet and juicy. It is a member of a small, ancient division of non-flowering plants with only three remaining genera, and a multi-nutrient species for industrial diet deficiencies.
Family: Gnetaceae
Names: Bicolano: nabo. Buhid: bagu. Cebuano: bago-sili, banago. English: spinach jointfir. Indonesian: melinjo, belinjo, maninjo, meninjo, karuk. Maguindanao: ma-gatungal. Malay: meninjau, emping melinju, kripik melinju. Portuguese: genemo. Spanish: bago, bulso, genemo. Tagalog: genemo, bago. Tausug: kugitas. Tok pisin: tu lip. Wú Chinese: xian zheu mai ma teng.
Form: Small to medium evergreen tree. Several subspecies are more shrubby.
Origin: Southeast Asia, New Guinea, and Pacific
Climate and Soils: Up to 1200 m. Tolerant of shade. 750-5000mm rainfall.
Vegetable and Other Uses. In addition to the cooked young leaves, the flowers, fruit, and nuts are also eaten. Also an important fiber crop.
Nutrition. Leaves are extremely high in iron, very high in fiber and Vitamin C, and high in magnesium, Vitamin A, and Vitamin E.
Growing Tips. Coppices well, and grown as a vegetable this way for best tender leaf production in Indonesia. Dwarf varieties are grown as vegetables in Thailand. Intercropped with many fruit trees and grown in tropical homegardens.
Propagation. Grown from seed, which must be scarified by drilling a small hole in the seed coat. Also grown from cuttings and air layering.

Figure 5.15. *Gnetum gnemon* is an excellent vegetable for shade.
Image Forest and Kim Starr, CC BY 3.0 US.

Tonaposo, Bush Apple (*Heinsia crinita*)
Cultivated as a vegetable in Nigeria, for home use and sales in local markets. The leaves are aromatic with a sweet smell of vanilla and hay (this scent may indicate the presence of toxic coumarins). Formerly *H. pulchella.*
Family: Rubiaceae

Names: English: Bush apple. Igbo: ata mirí. Yoruba: tonaposo.
Form: A small tree or semi-climbing shrub.
Origin: Tropical Africa.
Climate and Soils: Growing in the understory of evergreen forests.
Vegetable and Other Uses. The cooked leaves are eaten. The fruit is also eaten. The plant also has cosmetic and medicinal uses.
Nutrition. Extremely high in iron and zinc.
Growing Tips. Information unavailable.
Propagation. Grown from seed.

Figure 5.16. *Heinsia crinita* is one of several tree vegetables grown in Nigeria.
Image Bruno Senterre, CC BY-NC-ND.

Figure 5.17. Gardeners in central India have taken *Hymenodictyon orixense* into cultivation. Image Bhammar Chaal, CC BY-SA 2.0.

Bohar Bhaji, Kuthan (*Hymenodictyon orixense)*
Cultivated as a leaf crop in Chhattisgarh in India. Formerly *H. excelsum*.
Family: Rubiaceae
Names: Bengali: latikarum. English: kuthan. Gondi: guppudmaram, mac, minaboder. Hindi: kala bachnag, bhurkur. Marathi: kuda, kambal, dondru, or bhorsal, bhramarsali. Tamil: kadappu, nirkadambam, vellai-kadambu. Telugu: bandaaru-chettu, bandara.
Form: Small to medium tree.
Origin: Tropical Asia.
Climate and Soils: Tropical. 1200-2000 mm. 100-1700 m.
Vegetable and Other Uses. Leaves eaten.
Nutrition. Data unavailable.
Growing Tips. Needs more info.
Propagation. Grown from the very tiny seeds.

Balaban (*Hypobathrum microcarpum*)
Grown in Indonesia in the shade of fruit trees for its edible leaves. Leaves sold in markets there as well. Formerly *Petunga microcarpa*.
Family: Rubiaceae
Names: Javanese: apit, babalan. Sundanese: keehapit.
Form: Shrub or small tree.
Origin: Southeast Asia.
Climate and Soils: Humid lowland tropics, up to 500 m. Shade tolerant.
Vegetable and Other Uses. Young leaves and shoots eaten raw or cooked.
Nutrition. Not available.
Growing Tips. Sometimes grown in the shade of fruit trees in agroforestry systems in Indonesia.
Propagation. Information unavailable.

Uyoro (*Lasianthera africana*)
Cultivated in Nigeria for the edible leaves.
Family: Icacinaceae
Names: Igbo: kpurugiza, kpuruziza, uyoro, nka-nka.
Form: Shrub to 4 m tall.
Origin: West Africa.
Climate and Soils: Grows in the shady understory of forests and thickets.
Vegetable and Other Uses. Leaves cooked. Also has medicinal uses.
Nutrition. Information unavailable.
Growing Tips. Information unavailable.
Propagation. Information unavailable.

Gou-Qu-Tou, Goji (*Lycium chinense*)
See Chapter 4.

Kayu Nasi, Kipeit (*Maesa latifolia*)
Kayu nasi is cultivated in Indonesia as a home and commercial vegetable.
Family: Myrsinaceae
Names: English: kipeit. Indonesian: kayu nasi. Javanese: kipeit. Sundanese: Keepeeit. Wú Chinese: shu hua du jing shan.
Form: shrub or small tree.
Origin: Southeast Asia.
Climate and Soils: Humid lowland tropics.
Vegetable and Other Uses. Young leaves eaten raw and cooked.
Nutrition. Not available.
Growing Tips. Often managed as a fence, with frequent pruning or coppicing so it will continue to produce tender growth.
Propagation. Grown from cuttings and suckers.

Yuca, Cassava (*Manihot esculenta*)
See Chapter 4.

Nkweso, Tree Cassava (*Manihot carthaginensis subsp. glaziovii*)
See Chapter 4.

Figure 5.18. *Melientha suavis* is commercially grown and popular in soups. Image Takeaway, CC BY-SA 3.0.

Phakwan-Pa (*Melientha suavis*)
Phakwan-Pa is commercially grown in Thailand and elsewhere in Southeast Asia.
Family: Opiliaceae
Names: Thai: pak wan pa, phakwan-pa, kaeng phak wan. Vietnamese: rau ngost ruwfng, rau sawsng.
Form: Medium evergreen tree.
Origin: Southeast Asia.
Climate and Soils: Tropical lowlands.
Vegetable and Other Uses. In addition to the leaves and shoots, the flowers, unripe fruits, ripe fruit, and seeds are also eaten.
Nutrition. Very high in iron and Vitamin C, high in fiber.
Growing Tips. Hard pruning encourages robust growth of tender shoots. Grown in mixed-species agroforestry orchards with fruit trees. Can be difficult to cultivate, often wild-harvested.
Propagation. Grown from seed.

Iroko (*Milicia excelsa*)
Iroko is sometimes cultivated for the edible young leaves in tropical Africa, though it is primarily utilized as a timber species.
Family: Moraceae
Names: English: iroko. French: iroko, chêne d'Afrique, teck d'Afrique. Hausa: lóókó, loko. Igbo: ají, ojí, uloko. Kikongo: kambula. Kimbundu: mukuma, mukamba-kamba. Portuguese: mercira, amoreira, moreira, magundo, mgunde. Swahili: mvule. Tshiluba: lusanga. Umbundu: kamba. Yoruba: iroko.
Form: Large tree to 50 m.
Origin: Most of sub-Saharan Africa, excepting southern Africa.
Climate and Soils: Mostly in the humid lowlands, in deciduous or evergreen forest, gallery forest, or wet savanna. Up to 1200 m. Rainfall from 1100-1900 mm, but can tolerate lower rainfall and dry season of up to six months if underground water flow is available. Requires full sun and a fertile, well-drained soil.

Figure 5.19. *Milicia excelsa* is a timber species sometimes grown as a vegetable. Image Scamperdale, CC BY-NC.

Vegetable and Other Uses. Young leaves eaten. Older leaves are not recommended for eating as they are also used as sandpaper! Also used for firewood and charcoal, as a medicine, timber, and for its edible fruit used in juices.
Nutrition. Information unavailable.
Growing Tips. Coppices well. Easily grown from seed, which should be sown within three months of ripening. Also propagated by stem cuttings, root cuttings, and sometimes successfully from live stakes.
Related Species. A member of the mulberry family, which contains many genera of trees with edible leaves.

Noni, Indian Mulberry (*Morinda citrifolia*)
See Chapter 4.

Moringa, African Moringa (*Moringa* spp.)
See Chapter 4.

Hong Sang, Mulberry (*Morus alba*)
See Chapter 3.

Nopale Cactus, Prickly Pear (*Opuntia* spp.)
See Chapter 4.

Bongli, Sword Tree (*Oroxylum indicum*)
The sword tree is cultivated in Indonesia as a vegetable tree. Leaf flavor is somewhat bitter and the texture is mucilaginous. The tender edible shoots are very thick, resembling asparagus in appearance though not in flavor.
Family: Bignoniaceae
Names: Bengali: sona. English: Indian trumpet-flower, midnight horror, sword tree, kampong. Hindi: kutannat, dirghavrinta, patrorna, putivriksha, manduk, vatuk. Indonesian: bongli, bungli, bunga trompet. Javanese: kadjeng djaler, kayoo lanang, moongli, woongli. Malay: boongli. Marathi: tayitu, tetu. Sundanese: pongporang. Madurese: dhang-pedhangan. Mandarin Chinese: mu hu die. Russian: oroksilum indijskij. Tamil: achi pana, arandei, paiyaralandai, vangam, cori-konnai, puta-paspam. Telugu: tundilamu, pampena, manduka-parnamu, suka-nasamu. Thai: malikmai, pegah. Urdu: sona patha.
Form: Medium tree, semi-evergreen.
Origin: South and Southeast Asia from India to the Philippines.

Figure 5.20. *Oroxylum indicum* is grown for its leaves as well as its edible flowers and young pods. Image Vinayaraj, CC BY-SA 3.0.

Climate and Soils: Below 1000 m elevation. Humid tropics from 850-1300 mm annual precipitation with minimal or no dry season. Prefers sandy loam. Resprouts well after freezing. Thrives in shade.
Vegetable and Other Uses. Grown for the edible young leaves and flowers. The young pods are cooked as a vegetable. Also cultivated as a medicinal plant. Inner bark used for dye.
Nutrition. Very high in calcium, zinc, and Vitamin E; high in iron; medium in fiber and Vitamins A and C; and low in magnesium and folate.
Growing Tips. Reprouts well after heavy pruning.
Propagation. Grown from seed, cuttings, and root suckers.

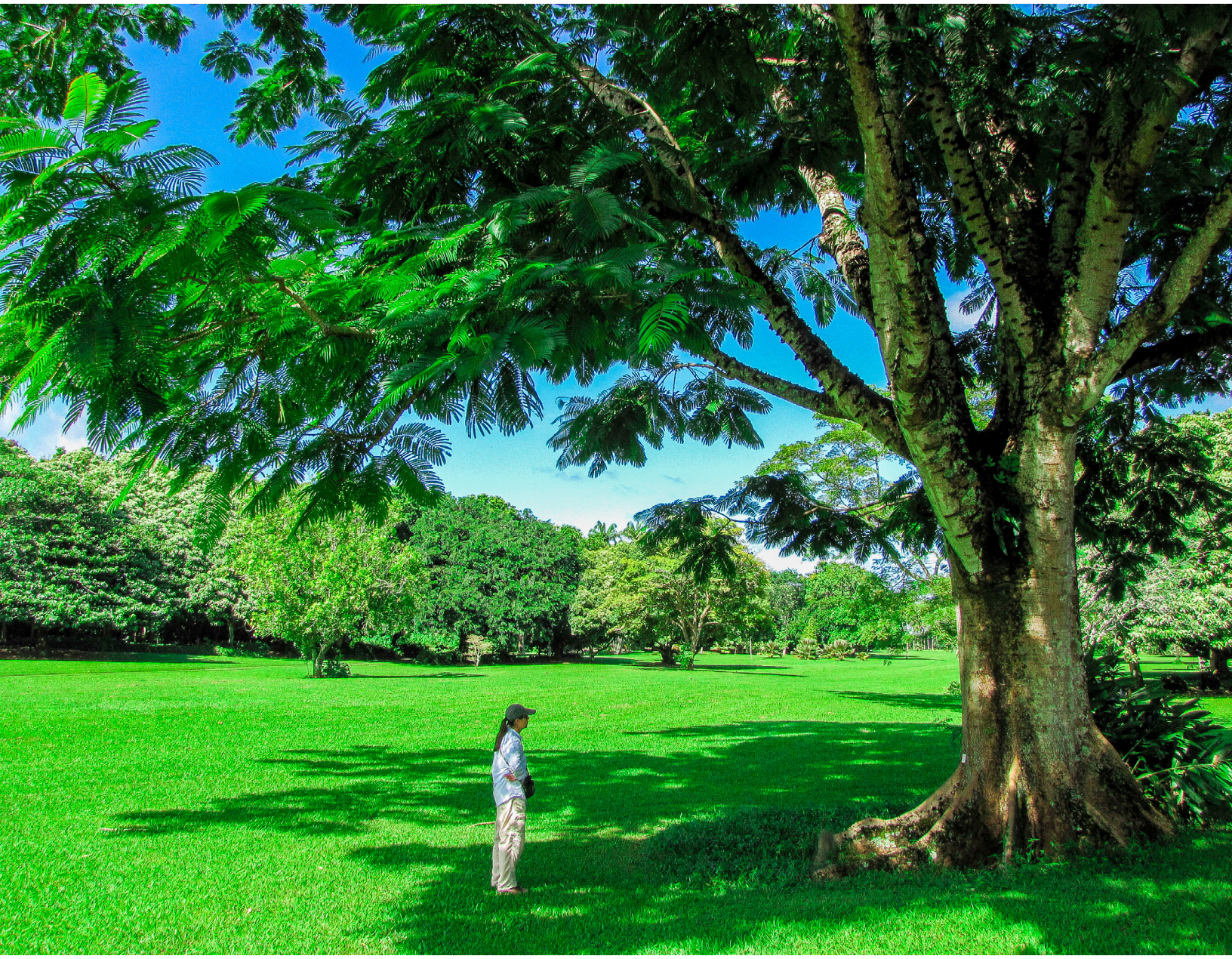


Figure 5.21. *Parkia timoriana* in Hawaii. Image Forest and Kim Starr, CC BY 3.0 US.

Yongchak, Tree Bean (*Parkia timoriana*)
Cultivated as a tree vegetable by the Meitei people in India for both the leaves and the pods. Formerly *P. roxburghii.*
Family: Fabaceae
Names: English: tree bean. French: arbre á haricots. Hindi: khorial, sapota. Indonesian: kedaung. Marathi: unkampinching. Meitei: yongchak. Spanish: árbol de los frijoles.
Form: Large tree.
Origin: Tropical Asia, New Guinea.
Climate and Soils: Tropical lowlands.
Vegetable and Other Uses. In addition the edible leaves, young seeds are eaten, pods are used for shampoo and medicinal uses. Used for firewood and timber as well, and grown for shade in coffee plantations.
Nutrition. Extremely high in iron; very high in calcium; medium in fiber, and Vitamins A and C.
Growing Tips. Coppices well. This species is a legume but does not fix nitrogen.
Propagation. Scarify seed by pouring nearly boiling water on seeds and soaking twelve to twenty-four hours before planting.

Ora Pro Nobis, Barbados Gooseberry (*Pereskia aculeata*)
Grown in gardens throughout Brazil for its edible leaves and fruit. This genus is the ancestor of most South American cacti (or very similar to it). A multi-nutrient species for industrial diet deficiencies. Some varieties are upright while others grow as groundcovers. Similarly, some varieties have much larger leaves and are better suited to vegetable use.
Family: Cactaceae
Names: English: Barbados gooseberry. French: grosseillier des Barbades, ronce d'Ameérique. German: Barbadosstachelbeere. Indonesian: kinrip. Portuguese: ora-pro-nóbis, lobrobô, carne-de-pobre, mata-velha, guaiapá, mori. Spanish: grosellero, ramo de novia, buganvilla blanca, guamacho
Form: Shrub or small tree.
Origin: tropical Americas
Climate and Soils: Tropical lowlands.
Vegetable and Other Uses. Young leaves are eaten. The flowers and fruits and also eaten.
Nutrition. Leaves are extremely high in fiber and zinc, and very high in calcium, magnesium, and Vitamin C. A top ten species for magnesium content.

Figure 5.22. *Pereskia aculeata* is a popular fruit and vegetable species in Brazil. Image João Medeiros, CC BY 2.0.

Growing Tips. Sometimes a climber but can be grown on its own as a shrub as well. Beware of the spines which can break off easily in the skin and cause inflammation.
Propagation. Grown from live stakes and seeds.

Figure 5.23. *Piper umbellatum* is a vegetable for shady areas. Image Scamperdale, CC BY-NC 2.0.

Kilemba Ki Mfinda, Shrubby Pepper (*Piper umbellatum*)
Like a handful of other species profiled in this guide, this is a species from the American tropics, (where it is eaten but not cultivated), which has become a crop in the Democratic Republic of Congo. The leaves taste of black pepper and celery.
Family: Piperaceae
Names: English: cow foot leaf, shrubby pepper. Kongo: Kilemba ki mfinda, lelembe, elembe, ilelembe. Mandarin Chinese: da hu jiao. Portuguese: caapeba, pariparoba, aguaxima, capeva. Spanish: cordoncillo.
Form: Semi-woody shrub.
Origin: American tropics.
Climate and Soils: A shade-loving species of the humid tropics, both lowlands and uplands.
Vegetable and Other Uses. Leaves are eaten.
Nutrition. Data are unavailable.
Growing Tips. Can be aggressive even in its native region.
Propagation. Grown from seed and cuttings.

Kol Banda, Lettuce Tree (*Pisonia grandis*)
One of the most widely consumed vegetables in Indonesia, Kol Banda is an important food in the Philippines as well. It is cultivated in India and Southeast Asia as a leaf crop and a multi-nutrient species for industrial diet deficiencies.
Family: Nyctaginaceae
Names: English: lettuce tree. French: árbre á choux. Hindi: bhagga-chura. Indonesian: kol banda, wijayakusuma. Javanese: kol banda, kol bandang. Malay: kol banda. Marathi: chinaisalit. Rodrigues Island Creole: bois mapou. Russian: Pizoniya bol'shaya. Solomon Islands Pijin: puka, rafarafa. Sundanese: kaleedjaja, kol banda. Tahitian: pu'atea. Tamil: chandu, muruval.
Form: Medium evergreen trees.

Figure 5.24. *Pisonia grandis* is an important vegetable from the coasts of Africa, Asia and the Pacific. Image Dinesh Valke, CC BY-SA 2.0.

Origin: A coastal species found from East Africa through Southeast Asia, New Guinea, Australia, and Pacific Islands.
Climate and Soils: Tropical lowlands, humid, full sun, growing in sand and coral atolls.
Vegetable and Other Uses. Young leaves raw and cooked. Also has medicinal uses. Planted as a windbreak, hedgerow, and mulch plant.
Nutrition. Very high in fiber, calcium, and magnesium. A top ten species for magnesium.
Growing Tips. Coppiced for leaf production, and grown as an edible hedge. The lighter-colored leaves of female plants (sometimes called "Alba") are preferred over those of males. The fruits stick to birds and other animals, and can entangle them enough to be deadly.
Propagation. As a vegetable mostly grown from cuttings of selected female forms ("Alba" and perhaps others), but can also be grown from seed.

Beluntas, Indian Camphorweed (*Pluchea indica)*
Beluntas is grown as a vegetable in Southeast Asia.
Family: Asteraceae.
Names: English: Indian pluchea, Indian camphorweed. Indonesian: beluntas, luntas. Japanese: hiragi-giku. Malay: beluntas. Mandarin Chinese: kuo bao ju, luan xi. Thai: khlu. Vietnamese: phat pha, cuc tan, tu bi.
Form: Evergreen shrub to 3 m high.
Origin: Southeast Asia. Listed in the Global Invasive Species Database.
Climate and Soils: Up to 1000 m elevation. Suited to poor, rocky soils, coastal areas, and wetlands. Somewhat salt tolerant.
Vegetable and Other Uses. Young leaves, shoots, and young inflorescences (unopened flower heads) are eaten raw or cooked. Primarily grown as a medicinal plant.
Nutrition. Extremely high in iron and high in calcium.
Growing Tips. Grown as a hedge. Intercropped in teak agroforestry systems.
Propagation. Easily grown from live stakes.

Figure 5.25. *Pluchea indica* is grown as a vegetable in Southeast Asia. Image Dinesh Valke, CC BY-SA 2.0.

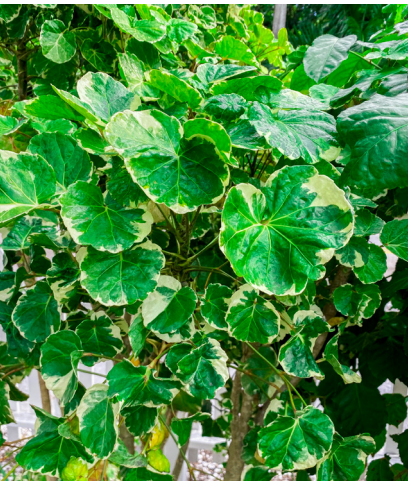


Figure 5.26. *Polyscias scutellaria* is a common vegetable hedge species. Image courtesy Erica Klopf.

Hedge Panax (*Polyscias cumingiana, P. fruticosa, P. scutellaria, P. verticillata*)
These common ornamental shrubs are important cultivated vegetables in their native range. Some, including *P. fruticosa,* have an aromatic flavor reminiscent of parsley. Some ornamental varieties at least have a somehat soapy flavor, but these are not varieties selected for vegetable use.
Family: Araliaceae
Names:

- ***P. cumingiana:*** English: panax. German: Farnblättrige Fiederaralie. Tagalog: bani.
- ***P. fruticosa:*** English: Ming aralia, panax. German: Rötliche Fiederaralie. Japanese: Taiwan momiji. Malay: Kedongdong. Mandarin Chinese: nan yang shen. Sundanese: kadongong. Madurese: kadoongdoong. Solomon Islands Pijin: berbero, geke. Tagalog: bani, papuá. Vietnamese: cay goi ca.
- ***P. scutellaria:*** English: panax. German: Glänzende Fiederaralie. Indonesian: daun mangkok, daun papeda. Javanese: gadong mangkokan, godong tjowékan, mangkokan. Malay: daoon mangkok. Sundanese: daoon mamangkokan, daoon mangkok. Madurese: daoon mangkok, pouring mangkok. Tagalog: salapiin.
- ***P. verticillata:*** English: panax. Tok Ples: valanguar, valangur. Solomon Islands Pijin: berbero, geke.

Form: Evergreen shrubs.
Origin: Southeast Asia, New Guinea, Solomon Islands. Widely grown as ornamental hedges throughout the tropics, and grown as an important leaf vegetable in the native range.
Climate and Soils: Tropical lowlands and subtropical, humid. Some species to higher elevations, including *P. cumingiana* which grows up to 1700 m. Require well-drained soil. Quite tolerant of shade though it is not required.
Vegetable and Other Uses. Young leaves and shoots eaten. They are aromatic, with a flavor similar to parsley. Used as a cooked vegetable in many dishes. Also a popular hedge. Because they are already so well distributed throughout the humid tropics as ornamentals, these species should be readily available outside of their native range.
Nutrition. *P. fruticosa* is extremely high in iron and very high in calcium. *P. scutellaria* is extremely high in calcium, very high in iron, and high in Vitamin C.
Growing Tips. Mostly grown as hedges but presumably adapted to coppice production as well. Propagated from live stakes and cuttings.

Lá Cách, Headache Tree (*Premna serratifolia*)
Grown for its sour leaves in tropical Asia.
Family: Lamiaceae
Names: English: headache tree. French: arbre á la migraine, bois sureau. Hindi: aegtha, arni, ustabunda. Japanese: Taiwan-no-kusagi. Mandarin Chinese: san xu xiu huang jing. Marathi: aeran, chamari. Tamil: alattuppacitam, panri munnai. Telugu: gabbunelli, kanika. Vietnamese: lá cách, vong cach, cach nui.
Form: Medium tree.
Origin: Coastal areas from Eastern Africa, through the Indian Ocean, to Southeast Asia, Australia, and Pacific Islands.
Climate and Soils: Humid tropical lowlands to 300 m.
Vegetable and Other Uses. Used as a cooked vegetable. Fruits and seeds are also edible.
Nutrition. Not available.
Growing Tips. Grown in hedges.
Propagation. Grown from seed and by layering.

Figure 5.27. *Premna serratifolia* is grown for its sour leaves. Image Lauren Gutierrez, CC BY-ND 2.0.

Figure 5.28. *Pseuderanthemum carruthersii* is a beautiful ornamental and an important food plant in the Solomon Islands. Image Mokkie, CC BY-SA 3.0.

Ofenga, False Eranthemum (*Pseuderanthemum carruthersii*)
Ofenga is a shrub grown as a vegetable in home gardens in the Solomon Islands. Gardeners there have selected forms with light-colored foliage that have better flavor. Indeed, ofenga is said to be among the most delicious greens in all the Pacific. A Pacific native but widely grown around the tropics as an ornamental, many forms with leaves in a range of colors including bright purples and yellows have been selected. Ofenga has the mild flavor of spinach and the texture of kale.
Family: Acanthaceae
Names: English: false eranthemum, Carruthers' falseface. Solomon Islands Pijin: ofenga.
Form: A shrub growing 1-6m high.
Origin: Pacific from Solomon Islands to Vanuatu.
Climate and Soils: Below 400m. Grows well on coral atolls where it is difficult to cultivate most vegetables. Lowland tropics. Sun to partial shade.
Vegetable and Other Uses. Leaves eaten raw and cooked.
Nutrition. Extremely high in magnesium, very high in iron, high in iron, high in zinc. A top ten species for magnesium.
Growing Tips. Grows from cuttings and live stakes. Grown as a hedge for daily harvest.

Figure 5.29. *Pterocarpus santalinoides* is one of several African vegetable crops in its genus.
Image Scamperdale, CC BY-NC.

Óha, African Pterocarps (*Pterocarpus mildbraedii, P. santalinoides, P. soyauxii*)
All three of these species are cultivated as vegetables in Nigeria, including *P. mildbraedii, P santalinoides,* and *P. soyauxii.* Pterocarps are nitrogen-fixing legumes. They are also cultivated as timber trees. The names of two of these species in Nigerian Igbo (*óha* and *úha*) mean "the tree with edible leaves". Several other species are also eaten, but these are the ones documented as cultivated vegetables. Domestication efforts are underway.
Family: Fabaceae
Names:

- ***P. mildbraedi:*** Hausa: mádoóbíyaá, gennigar, uruhe, uru-kho, panatan, ire, yabmatchal, madobiyar rafi. Igbo: óha ojií, ogasji, óra, óha, úha. Ijaw: geneghar. Yoruba: gbodogbodo.
- ***P. santalinoides:*** Edo: akumeze. English: Gambia kino. Hausa: chi ka a-fere, totohoti, gbingbin, aku-emzi, nja, gedar-kurumi, por-pori, ositua, gunduru, gyadar kurmi. Igbo: ntúrúkpá, utulukpa, otolokpam, mbo rei, nteropa, nturukpa. Tiv: kereke. Yoruba: gbengbe, gbíngbin odó, idogun.
- ***P. soyauxii:*** Edo: akume. English: African padauk, kino. French: bois rouge. Igbo: awo, nturukpa, óha, óra, úha, ufie, uhie, ukpi, ihie. Yoruba: iye, osún-pupa, atu, boku, mbea, igbuli, mbondi, uhiye, osunpupa, wosoka, mbe, padouk, nkui-yang.

Form: Evergreen trees, medium to large.
Origin. West and Central Africa. *P. santalinoides* also grows wild in eastern tropical South America, one of a number of species found both in South America and Africa.
Climate and Soils. Found in rainforest, dry evergreen forest, and gallery forest, as high as 1250m. Can handle acid soils.
Vegetable and Other Uses. The leaves are used cooked. Leaves are sold in markets. Used for shade in coffee agroforestry systems. Wood of several species used for a red dye. Seeds of *P. santalinoides* are very poisonous but eaten after processing (it is even grown for the seeds in S. Dahomey).
Nutrition. *P. mildbraedi* is extremely high in magnesium; very high in iron and zinc, and high in calcium. *P. mildbraedii* is a top ten species for zinc and magnesium.
Growing Tips. Propagated with seed and cuttings. Fast growing, and strongly coppicing. Produces flushes of tender growth in the dry season. Use cowpea inoculant in soils lacking nodulated legumes, but apparently some strains are more productive than others.

Seengogo, Blue Fountain Bush (*Rotheca serrata*)
Grown as a vegetable in Indonesia for its young leaves and inflorescences, which are somewhat bitter.
Family: Lamiaceae
Names: English: beetle killer, blue fountain bush, blue glory. Hindi: bharanji. Javanese: Senggoonggoo, sreegoonggoo. Malay: senggoogoo. Marathi: ganthu bharungi, bharang, bharangi. Sundanese: seengogo. Tamil: chirudekku, ciru-tekku. Telugu: banal chettu.
Form: Shrub or small tree.
Origin: South and Southeast Asia.
Climate and Soils: Up to 1800m, humid tropics.
Vegetable and Other Uses. In addition to the edible leaves, seengogo is grown as a medicinal plant and an ornamental hedge.
Nutrition. Unavailable.
Growing Tips. Mostly grown from live stakes, also from seed and transplanting of suckers. Grown as a hedge as well.
Propagation. Grown from seed.

Figure 5.30. *Rotheca serrata* is an Indonesian vegetable shrub.
Image Shagil Kannur, CC BY-SA 4.0.

Oseille chinoise (*Rumex usambarensis*)
A great diversity of species of *Rumex* are grown as vegetables in temperate, tropical, and even subarctic climates, including garden sorrell. This semi-woody species, reaching up to 4.5m tall, is cultivated as a vegetable in the Democratic Republic of Congo. The flavor is sour and somewhat salty.
Family: Polygonaceae
Names: French: Oseille chinoise.
Form: Semi-woody shrub.
Origin: Central Africa.
Climate and Soils: Humid tropics, lowlands and highlands up to 2500m, in sun or partial shade.
Vegetable and Other Uses. Leaves and stems are eaten raw or cooked
Nutrition. Unavailable.
Growing Tips. Information unavailable.
Propagation. Information unavailable.

Figure 5.31. *Rumex usambarensis,* a 4.5 meter tall relative of garden sorrel. Image Scamperdale, CC BY-NC 2.0.

Figure 5.32. A hedge of *Sauropus androgynus.* Image courtesy Josh Jamison.

Katuk (*Sauropus androgynous*)
A popular home garden and commercial vegetable in much of Asia. Notable for its high yields in shade. Overconsumption of katuk juice has proved fatal on at least one occasion, so caution should be used in heavy consumption of this species, at least in juice form. A multi-nutrient species for industrial diet deficiencies.
Family: Phyllanthaceae
Names: English: katuk, star gooseberry. Indonesian: katuk, katu, memata, cekop manis. Mandarin Chinese: shou gong mu, pa wan. Malay: cekur manis, chekor manis, chekkurmanis, asin-asin, cangkok manis. Tamil: pallikkarputu. Thai: pak wan.
Form: Evergreen shrub.
Origin: South and Southeast Asia.
Climate and Soils: Tropics and subtropics up to 400m, or occasionally much higher. Rainfall is ideally 900-1200mm, but can tolerate 600-4000mm. Prefers light shade but will produce in sun or heavy shade as well.
Vegetable and Other Uses. Mostly grown for the leaves, but the fruits are also edible. Also used for medicine and dye. Used as a living fence and for crop shade in agroforestry systems.
Nutrition. Extremely high in Vitamin E and very high in iron and Vitamins A and C.
Growing Tips. Grown as a hedge or in coppice systems. Falls over if not pruned back regularly.
Propagation. Grown from seed and cuttings.

Cha Om, Garlic Acacia (*Senegalia pennata*), Som poi (*S. rugata*)
Both species are grown as leaf vegetables in Southeast Asia. *S. pennata* is sometimes called garlic acacia due to the strong flavor of the leaves, which taste of garlic, salt, sweet, and fish. *S. rugata* has a sour flavor like tamarind. Both species were formerly in the genus *Acacia.*
Family: Fabaceae
Names:

- ***S. pennata:*** English: garlic acacia. Hindi: aila, biswal, chilata. Marathi: shembarati, shembi. Tamil: seengai, vellai indu, inthu, kattintu, kattuchikai. Telugu: guba korinda. Thai: cha om, pak lat.
- ***S. rugata:*** Arabic: shekakai. Hindi: rithra, koci. Marathi: shikakaayi, reetah. Tamil: cikaikkai, sheekay. Telugu: chika-kai, seege. Thai: som khon, som poi. Urdu: shikakai.

Figure 5.33. Harvest of *Senegalia pennata.* Image courtesy Rick Burnette.

Form: *S. pennata* and *S. rugata* are small spiny trees which can also climb as vines.
Origin: *S. pennata* is native from India through Southeast Asia all the way to N. Australia. *S. rugata* is native through most of that range as well.
Climate and Soils: Humid lowlands. *S. pennata* grows up to 1,500m elevation, while *S. rugata* grows from 50-1050m.
Vegetable and Other Uses. Cooked young leaves. Fruits and pods of *S. rugata* are also cooked as vegetables. The pods of *S. rugata* are marketed locally for use as soap.
Nutrition. *S. pennata* is very high in fiber and iron, and high in zinc. *S. rugata* is extremely high in zinc and very high in fiber. *S. rugata* is a top ten species for zinc.
Growing Tips. Both species fix nitrogen. *S. pennata* is sometimes managed as a hedgerow. Shoots of this species can be harvested when growing vigorously, and thorns on new shoots are soft and can be cooked and eaten. Thorns on older leaves are very sharp. Martin Price of Educational Concerns for Hunger Organization reported that a garlic acacia tree grew at their Florida demonstration site for many years as a well-behaved small tree. Then one day its branches brushed against a nearby tree, and it transformed into a spiny vine that quickly climbed a 30-meter tree and began to strangle it. Many growers have reported that *S. pennata* can be very weedy and difficult to eradicate.
Propagation. Most acacias can be grown from seed. Pour boiling water onto seeds, and soak 12-24 hours. If not swelling after that time, cut the seed a bit with a knife (scarify) and soak again.

Figure 5.34. *Senna obtusifolia* is being developed as a new crop by African farmers. Image Pieria, public domain.

Opa Iku, Sicklepod (*Senna obtusifolia)*
It is curious that this species, widely grown as a medicinal plant for its powerful laxative effect, is grown as a vegetable. Though native to the Americas, it is grown as a leaf crop in home gardens in Cameroon, Ethiopia, Ghana, and Senegal. Sicklepod has been identified as having potential for further breeding as a vegetable in Africa. Breeding work to date by farmers has selected for reduced bitterness, reduced fiber, and easier harvest. Some sources report that only the older leaves which are laxative (and also highly toxic to grazing livestock). It is a legume but does not produce nitrogen-fixing nodules. A multi-nutrient species for both traditional malnutrition and industrial diet deficiencies.
Family: Fabaceae
Names: English: sicklepod. French: séné, casse fétide. In Senegal: ulo, ulodé sambaduro. Spanish: ejotillo cafecillo. Wolof: ndur. Yoruba: ako rere, opa iku, asimawu.
Form: A shrub growing up to 2m high, though some forms are annuals.
Origin: Tropical Americas.
Climate and Soils: Found at up to 1700m. Tropics and subtropics, and temperate as an annual. Humid. Growing in colder climates as an annual. Rainfall from 640-4290mm, best at about 1500mm. Soil pH 4.6-7.9.
Vegetable and Other Uses. The young leaves are eaten cooked, as are the flowers and tender young pods. They are slightly bitter with a desirable consistency. Seeds are commercially grown as a laxative and to produce industrial gums.
Nutrition. *S. obtusifolia* is extremely high in iron and Vitamin A; very high in calcium and Vitamin C. A top ten species for Vitamin A.
Growing Tips. Weedy. Grown from seed. Pre-soak for 12 hours in water or scarify seed to speed up germination.

Katuray, Vegetable Hummingbird (*Sesbania grandiflora)*
Grown as a vegetable in India and Southeast Asia, notably in the Philippines. The flowers are a prized vegetable in Southeast Asia. Leaves have a flavor and teture similar to globe artichoke. A multi-nutrient species for industrial diet deficiencies.
Family: Fabaceae
Names: Bengali: agati, bak, buko. English: agati sesbania, vegetable hummingbird. French: fagotier. German: Turibaum. Hindi: agasti, basna, hathya, gaach-munga. Indonesian: turi, tuwi. Javanese: senggoonggoo, sreegoonggoo. Malay: senggoogoo, getih, turi, kachang turi, kelur.

Figure 5.35. *Sesbania grandiflora* is a multipurpose legume tree with edible leaves.
Image Forest and Kim Starr, CC BY.

Marathi: shevari, hatga. Sundanese: seengogo. Tagalog: katuray. Tamil: agati, akkati, muni, sevvagatti. Telugu: ettagise, sukanasamu. Thai: khae baan. Urdu: agast. Vietnamese: ang kea dey, danh ca.
Form: Medium deciduous tree.
Origin: Southeast Asia and perhaps farther east and west.
Climate and Soils: Tropical humid lowlands up to 1000m elevation. Prefers rainfall 2000-4000mm but tolerating less. Full sun. Killed by frost and will not resprout.
Vegetable and Other Uses. Leaves, flowers, and young pods are popular vegetables. Fermented seeds are eaten as well. Used medicinally. A multipurpose agroforestry species used for crop shade, nitrogen fixation, windbreak, living fence, and living trellis.
Nutrition. Extremely high in fiber and calcium, very high in iron and magnesium, and high in zinc and Vitamins C and E. A top ten species for calcium content.
Growing Tips. Fast-growing but often dies if completely defoliated – make sure to leave some branches uncut. Best lopped or pollarded above 1.5m. Inoculate with cowpea *Bradyrhizobium* if inoculation is needed.
Propagation. Grown from seed, sometimes scarified by pouring boiling water over seeds and soaking 12-24 hours. Also grown from rooted cuttings.

Papelillo (*Sinclairia sublobata*)
See Chapter 4.

Bangko, Spiral Nightshade (*Solanum spirale*)
Ubiquitous in kitchen gardens of the Adi people in Northeast India, and grown in home gardens in much of South and Southeast Asia.
Family: Solanaceae.
Names: Adi: bangko. Assamese: loya tita, titakuchi. English: spiral nightshade. Hindi: mungaskajur. Mandarin Chinese: xuan hua qie.
Form: Shrub to 4m high.
Origin: South Asia, Southeast Asia, Australia.
Climate and Soils: Tropical, growing up to 1900m elevation.
Vegetable and Other Uses. Young leaves and fruits cooked as a vegetable. Bitter. Also has medicinal uses.
Nutrition. High in fiber. Leaves in this genus often contain toxic solanine.
Growing Tips. Information unavailable.
Propagation. Grown from seed and cuttings.

Figure 5.36. *Solanum spirale* is a leaf and fruit vegetable in Asia. Image VanLap Hoáng, CC BY 2.0.

Figure 5.37. *Spondias dulcis* is grown for its fruit and its sour leaves. Image courtesy Josh Jamison.

Makok Nam, Ambarella (*Spondias dulcis*)
While grown as a fruit around the tropics, golden apple is also grown as a leaf vegetable in Thailand and elsewhere. The leaves have a strong lemon flavor with hints of salt.
Family: Anacardiaceae
Names: English: golden apple, ambarella. French: mombin rouge, prunier de Antilles, casamangue. German: Rote Mombinpflaume. Indonesian: kedondong jawa, kedondong manis. Mandarin Chinese: jen mien tzu. Portuguese: ambu, caja, ombuzeiro. Spanish: ciruela del fraile, jocote, ambarella. Thai: makok nam.
Form: Medium tree.
Origin: Southeast Asia, New Guinea, Pacific Islands.
Climate and Soils: Up to 950m. Tropics and subtropics. Rainfall 900-1800m.
Vegetable and Other Uses. Grown as a leaf vegetable and also for the fruit, which somewhat resembles the related mango.
Nutrition. Unavailable.
Growing Tips. Sometimes grown as a living fence, which would provide plenty of tender young shoots to eat.
Propagation: Grown from seed, live stakes, and air layers.

Bumald Bladdernut (*Staphylea bumalda*)
See Chapter 3.

Chinese Toon (*Toona sinensis*)
See Chapter 3.

Figure 5.38. *Trevesia palmata,* one of the many trees with edible leaves in the Aralia family.
Image Wendy Cutler, CC BY-SA 2.0.

Tang Pa, Snowflake Tree (*Trevesia palmata*)
Cultivated as a vegetable in Thailand in some home gardens.
Family: Araliaceae
Names: English: snowflake tree. German: Schneeflockenbaum. Mandarin Chinese: ci tong cao. Thai: tang pa, tang pha, tang luang.
Form: Small tree.
Origin: Northern Southeast Asia.
Climate and Soils: Tropical and subtropical. To 1500m. A forest plant, usually found in moist, shaded locations.
Vegetable and Other Uses. Tender leaf shoots are cooked as a vegetable, as are the young flower buds.
Nutrition. Not available.
Growing Tips. Information unavailable.
Related Species. Grown from seed (often germinating under mother plants) and most commonly from stem cuttings.

Haitian Basket Vine (*Trichostigma octandrum*)
See Chapter 4.

Urtigão , Cow-Itch (*Urera baccifera*)
This “nettle tree” produces a very painful sting when touched. The sting is much more powerful than that of stinging nettle (*Urtica dioica*) and lasts for several days. The cooked leaves are a popular vegetable in Brazil, where it is cultivated by some gardeners as a food crop.
Family: Urticaceae
Names: English: cow-itch, Caesar weed. French: feuilles enragées, mamon guêpes. Portuguese: urtigão, urtiga-roxa, ortiga brava, ortiga grande, ortiga colorado. Spanish: cadillo, chichicaste, pringamoza.
Form: Shrubs to 6m tall.
Origin: tropical Americas
Climate and Soils: Lowland humid tropics, but also growing to 1500m or higher when planted. Sun to part shade.
Vegetable and Other Uses. The thoroughly cooked leaves are a delicious vegetable. The small, sweet white fruits are also eaten. Grown as a minor fiber crop as well. This species has many medicinal uses.
Nutrition. Information unavailable.
Growing Tips. Be careful of the stinging hairs! Sometimes used as a living fence. Coppices very well. Both male and female plants are needed for fruit production.
Propagation. Grown from live stakes and seed.

Figure 5.39. *Urera baccifera,* a woody relative of the popular wild vegetable stinging nettle. Image Victor Farialla, CC0 1.0.

Ndole, Sweet Bitterleaf *(Vernonia hymenolepis)*
Cultivated commercially and home gardens in Cameroon and Nigeria. Grown in intensive irrigated farms in Benin. Frozen leaves are exported from the region to African markets in Europe. Domesticated forms are much less bitter than wild species, demonstrating that farmers in the region have worked for many years to improve this woody vegetable. Now grown commercially by Asian immigrant farmers in Florida, USA, showing that this is becoming a globally important vegetable.
Family: Asteraceae.
Names: Berom: etulúp. In Cameroon: ndole. Dera: wólóm. Edo: óríwó. English: sweet bitterleaf. French: virnonie douce, vernonie. Fula-Fulfulde: kadkadde, siwaakewal. Hausa: chusar doki, fatefate, mayemaye, shiwáákáá. Ibibio: átídót. Igbo: ólúgbú, ólúbí, ónúbú, ólúbí. Ijo-Izon: kíríólógbó. Ngemba: yinna. Tiv: ityuna. Yoruba: ewúró, ewúró jíje, ewúró oko, orín, pákó.
Form: Shrub or small tree.
Origin: Tropical Africa.
Climate and Soils: Full sun. Tolerant of a wide range of soils. Really a species of tropical highlands, preferring altitudes from 1400-3000m, though it can grow at lower altitudes. Requires at least 840mm annual precipitation. Does not like drought and should be irrigated in dry seasons. Resprouts well after frost.
Vegetable and Other Uses. Young leaves are cooked. They are sometimes rubbed to remove bitterness. Boiling for 5 minutes with limestone is another technique.
Nutrition. Very high in zinc; high in calcium and iron.
Growing Tips. Grown as a hedge around the home or coppiced to 5-10cm high. Spaced at 20x30cm, or 75x75cm for intercropping. Easily grown from seed. Superior forms can be propagated with live stakes, with at least 4 buds on each cutting, and planting at a slanting angle. Live stakes not always successful however.
Propagation. Grown from seed and hardwood cuttings.

Figure 5.40. *Vernonia hymenolepis* was selected from its bitter wild ancestors by West African farmers. Image Scamperdale, CC BY-NC 2.0.

Black Plum (*Vitex doniana*)
See Chapter 4.

Japanese Prickly Ash (*Zanthoxylum ailanthoides*)
See Chapter 3.

APPENDIX A

Nutrition Information

This table provides information on the nutrient content of trees with edible leaves. It focuses on the nutrients that are missing in human diets as described in Chapter 1 and in the 2020 PAI paper "Perennial vegetables: A neglected resource for biodiversity, carbon sequestration, and nutrition". The figures presented here show the average values based on our meta-analysis. Data sources include our 2020 paper as well as other papers listed in the references. Data were available for 51 of the 102 species profiled.

The values are ranked using the values from PAI's 2020 paper, which compares them to a group of widely grown and marketed "reference vegtables" as summarized in Chapter 1. Table A.1 shows these values and the corresponding color codes used in Table A.2 to indicate the ranking for each nutrient concentration (only the colors for the highest three rankings are used to highlight this important information). All nutrients are reported per 100g fresh weight. "Extra high" is more than twice as high as the highest reference vegetable value for that nutrient. "Very high" is higher than the highest reference vegetable but below extra high. "High," "medium", and "low" refer to the top, middle, and bottom thirds of the values reported for the reference vegetables. "Very low" rankings are below the lowest values reported for reference vegetables. Note that there is no "very low" for Vitamin A, as zero is the lowest value for reference crops. The high prevalence of purple, red, and orange in Table A.2 shows just how extraordinary trees with edible leaves are as a class, even though not all of these species are notable. Blank spaces indicate absence of data, and should be a priority for future research.

Table A.1. Nutrient concentration rankings

	Fiber	Calcium	Iron	Magnesium	Zinc	Vitamin A	Folate	Vitamin C	Vitamin E
	%	mg/100g	mg/100g	mg/100g	mg/100g	RAE mg/100gm	mcg/100gm	mg/100g	mg/100g
Extra high	7.16+	477.41+	4.22+	171.01+	1.13+	1.12+	388.01+	233.60+	5.09+
Very high	3.59-7.15	238.71-477.40	2.12-4.21	85.51-171.00	0.57-1.12	0.56-1.11	194.01-388.00	116.81-233.59	2.55-5.08
High	2.51-3.58	161.58-238.70	1.56-2.11	60.27-85.50	0.43-0.56	0.38-0.55	132.64-194.00	79.02-116.80	1.43-2.54
Medium	1.46-2.50	86.72-161.57	1.02-1.55	35.76-60.26	0.30-0.42	0.19-0.37	73.08-132.63	42.34-79.01	0.74-1.42
Low	0.40-1.45	11.85-86.71	0.47-1.01	11.25-35.75	0.16-0.29	0-0.18	13.50-73.07	5.65-42.33	0.05-0.73
Very low	0-0.39	0-11.84	0-0.46	0-11.24	0-0.15	0-0	0-13.49	0-5.64	0-0.04

Table A.2. Nutrient values of trees with edible leaves

Latin Name	Fiber %	Calcium mg/100g	Iron mg/100g	Magnesium mg/100g	Zinc mg/100g	Vitamin A RAE mg/100g	Folate mcg/100g	Vitamin C mg/100g	Vitamin E mg/100g
Abelmoschus manihot	1.80	369.57	2.97	48.00	0.73	0.31		86.00	3.26
Adansonia digitata	1.99	297.38	1.83	26.00	0.85	0.23	36.75	61.50	4.01
Aralia elata	2.81	56.86	3.62	41.01	0.98	0.12	145.50	10.78	2.73
Atriplex halimus	5.74	674.33	25.30	456.00	3.00				
Azadirachta indica	11.60	162.00	2.70		0.40	0.40		92.00	
Balanites aegyptiaca	7.90	115.88	3.40	17.98	0.13	0.17		46.65	14.40
Bauhinia purpurea	4.86	109.42	6.36			0.07		24.29	
Broussonetia luzonica	2.40	282.00	6.80			0.10		24.00	
Ceiba pentandra	1.83	187.90	6.49	180.52	1.41	0.03	1.02	27.41	
Clerodendrum glandulosum	3.01	24.70	2.20	69.80	1.94				
Cnidoscolus aconitifolius	2.40	277.67	4.60	88.00		1.38		216.67	
Crotalaria longirostrata	2.48	314.00	4.70			0.33		83.32	
Eleutherococcus nodiflorus	4.21	109.74	1.09	104.34	0.60				
Eleutherococcus senticosus	8.80	211.00	3.43	55.00	1.18	0.81	183.00	100.73	8.44
Eleutherococcus trifoliatus	11.50	382.97	3.87			1.44		21.03	
Erythrina berteroana	2.40	108.00	2.20			0.02		37.00	
Ficus copiosa		822.50	0.98	143.50	0.98	0.21			
Ficus lacor						0.32			
Ficus thonningii	2.21	285.17	5.12	45.33	0.24				
Gnetum gnemon	6.30	150.74	4.36	70.00	0.40	0.55		131.33	2.00
Kalopanax septemlobus	5.06	172.19	3.72	91.94	1.11	0.08	102.00	9.66	0.00
Lycium chinense	1.40	188.75	3.33	188.50	0.40	0.39	72.50	18.87	6.51
Manihot esculenta	3.15	230.00	3.95		1.79	0.90	95.00	263.33	13.06
Melientha suavis	3.40		3.70			0.26		141.50	
Morinda citrifolia	3.34	320.89	2.62	125.44	0.54	1.18		53.50	
Moringa oleifera	1.36	107.98	3.47	112.00	0.63	0.30	73.79	218.62	1.62
Moringa stenopetala	12.86	490.25	3.08		0.33	0.01		17.35	
Morus alba	3.85	593.43	11.37	117.01	1.15	0.48	208.00	139.94	0.09
Opuntia cochenillifera	6.80		2.70			0.04	16.00		
Opuntia ficus-indica	1.98	96.66	0.60	41.87	0.18	0.09	3.00	11.58	0.00
Oroxylum indicum	1.29	26.00	1.26			0.58		97.00	4.16
Pereskia aculeata	9.50	320.67	1.42	153.33	2.67	0.35	19.30	185.00	
Piper auritum	1.80	297.00	5.07			0.34		52.67	
Pisonia umbellifera	5.40	310.00	1.02	165.00	0.33			34.00	
Pluchea indica	1.34	185.33	5.80			0.15		22.72	
Polyscias fruticosa		474.00	6.20			0.08		29.00	
Polyscias scutellaria		480.00	2.28			0.19		83.00	
Pseuderanthemum carruthersii	1.70	330.00	0.39	405.00	0.50	0.22		51.00	
Pterocarpus mildbraedii	1.42	201.00	2.55	216.50	1.80			51.00	
Sauropus androgynus	1.73	161.57	3.16			0.88	110.00	123.86	6.25
Senegalia caesia		149.72	8.25		0.44				
Senegalia pennata	3.90	41.00	2.50		0.50	0.09		47.00	
Senegalia rugosa	3.98	1.00	0.70	13.40	9.00				
Senna obtusifolia	2.45	349.50	6.15	40.00		1.31		120.50	
Senna siamea	4.39	94.86	2.64			0.27		141.20	
Sesbania grandiflora	7.80	577.50	3.59	96.94	0.53	0.19	120.00	91.67	1.77
Solanum spirale	3.27	11.29							
Tilia cordata	0.17	120.95	1.49	28.15	0.45	0.15	33.40		
Toona sinensis	3.44	282.73	4.49		0.98	1.58	58.67	90.26	15.22
Vernonia hymenolepis	1.46	163.67	1.80		0.63	0.24	96.00	49.67	0.87
Vitex doniana	1.85	51.70	17.29			0.18		32.98	53.36

APPENDIX B

Resources

All of the publications in the References section are well worth reading. In addition, here we present a select few organizations, websites, and readings. They provide information and in some cases seeds and cuttings as well.

Agroforestry Research Trust
https://www.agroforestry.co.uk/
Workshops, publications, plants and seeds. UK.

Educational Concerns for Hunger Organization
https://www.echocommunity.org/
Trainings, network, and free seeds and cuttings for development projects. With demonstration centers in Burkina Faso, Tanzania, Thailand, and Florida USA.

Food Plants International
https://foodplantsinternational.com/
Global database of food plants, outstanding downloadable publications. Australia.

How to Grow Perennial Vegetables: Low-Maintenance, Low-Impact Vegetable Gardening
Martin Crawford, 2012, Green Books.

Indian Horticulture magazine
https://epubs.icar.org.in/index.php/IndHort/issue/view/2991
Special issue on Indigenous vegetables of India.

Las Canadas Agroecology and Permaculture Center
https://bosquedeniebla.com.mx/
Workshops, demonstration center, outstanding nursery and seed company. Mexico.

Leaf for Life
https://www.leafforlife.org/
NGO dedicated to leaf crops and nutrition. Excellent publications.

Mansfeld's World Database of Agricultural and Horticultural Crops
https://mansfeld.ipk-gatersleben.de/
Online database of over 6,000 cultivated crops. Also available as a comprehensive, very expensive book set.

Perennial Agriculture Institute
https://perennialagriculture.institute
Publications and workshops on perennial crops and agroforestry. USA.

Perennial Vegetables: from Artichoke to Zuiki Taro, a Gardener's Guide to Over 100 Delicious, Easy-to-Grow Edibles
Eric Toensmeier, 2007, Chelsea Green Publishing

“Perennial vegetables: A neglected resource for biodiversity, carbon sequestration, and nutrition”
https://journals.plos.org/plosone/
PAI research on perennial vegetables including trees with edible leaves.

Plant Resources of Tropical Africa
https://prota.prota4u.org/
Online database. Also book series, with vegetable volume in print.

Plant Resources of Southeast Asia
https://prosea.prota4u.org/
Online database and fully published book set.

Plants for a Future.
https://pfaf.org/
Online database of useful temperate plants and more.

The Ferns Tropical Useful Plant Database
https://tropical.theferns.info
Online database.

World Agroforestry Centre
https://www.worldagroforestry.org/
Global organization with events, publications and more. Kenya.

World Vegetable Center.
https://avrdc.org/
Publications, events, seeds and plants. Thailand.Nutrition database at http://nutrition.worldveg.org/http://nutrition.worldveg.org/

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