

# Favored Trees of the Maya Milpa Forest Garden Cycle

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## Abstract

Comparisons of Maya forest gardens, the economic botany of the Maya forest, and identifications of plant remains in archaeological contexts converge on the value of the Maya forest as the reflection of the selective favoring of useful plants over time and across space. We have evaluated trees conserved in Maya milpas and present here an annotated list of significant categories of uses that transcend the ordinary, and highlight the extraordinary appreciation of plants and their role in the historical and cultural ecology of land use. Recognition of land cover significance, biodiversity, water conservation, erosion management, soil fertility principles, animal habitat essentials, and support for communities are all entangled with the role of plants. With an example of 160 confirmed trees favored in Maya milpa agricultural fields, we provide a window into economic values that dominate the Maya forest.

**Keywords:** tropical forests, Maya forest, forest gardens, domesticated landscape

## 1. Introduction

Ancient Mesoamericans, including the Maya, practiced rainfall-dependent agriculture rooted in resourceful ingenuity and the skillful use of stone tools and fire (**Figure 1**). Land use strategies in the Americas emerged without major capital investments in plows or cows. The landscape of the Americas depended on interrelationships among people and their observations of environmental processes. In this sense, Mesoamericans worked with nature, and over millennia of trial and error created their domesticated landscape [1–3].

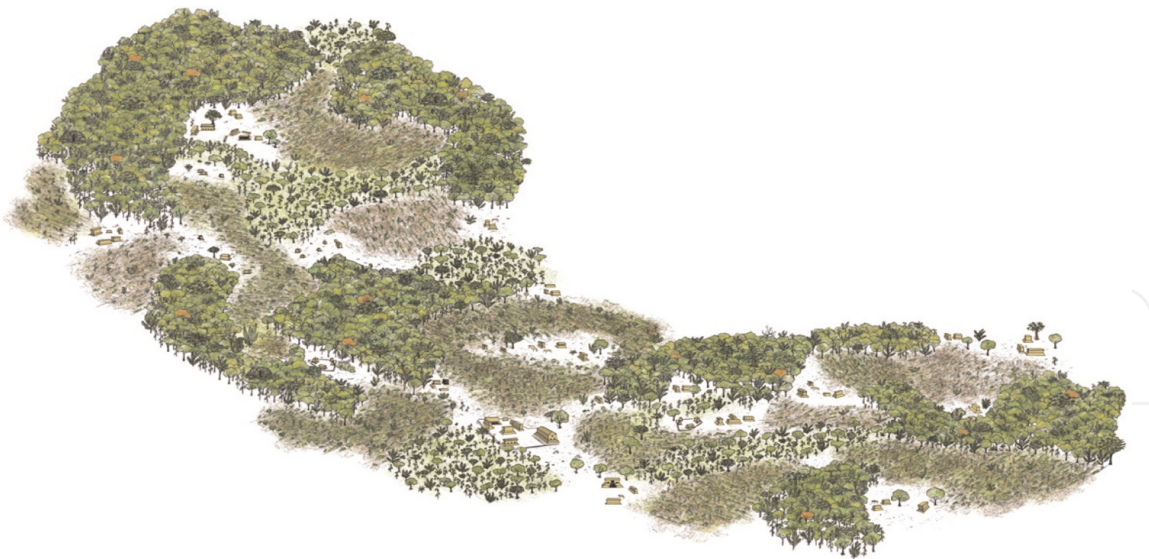
Cropped fields of annuals cycled across the landscape, integrally creating complexity within the phases of forest regeneration while reducing erosion and maintaining soil fertility (**Figure 2**). For the Maya, it was not a choice between cultivated fields and forest (**Figure 3**), as it often appears to Western eyes. In Europe, *cultivable* has long been equated with *arable*, the original meaning of which is plowable. Maya agriculture was based on intimate engagements with nature that integrated subsistence strategies within the context of environmental management [4]. The Maya, both past and present, have directed exuberant



**Figure 1.** Regional Landforms of the Central Maya Lowlands with Major Ancient Maya Centers Indicated. Credit: MesoAmerican Research Center.

tropical growth towards human requirements, resolving the needs of everyday life with labor, knowledge, and skill [5–10]. Without the field, there could be no useful forest and without a useful forest there would be no productive field. The growth and expansion of Maya civilization across the millennia was based on reliable resource management practices that have left their imprint on the forest itself in the form of its dominant plants, which are all economically useful [1, 11, 12].

For the Maya forest to provide basic household requisites, farmlands must have varying soil qualities, materials for construction and utensils, fibers and spices, resources for food production [13–15], and habitat for game animals [16–19]. The topography and diverse landscape comprise upland ridges and hills interspersed with



**Figure 2.**  
*The Milpa Cycle showing the phases of the cycle of annual and perennial spaces. Credit: MesoAmerican Research Center.*

wetlands and transitional zones. This is the essential palette on which the Maya developed strategic land cover designs that not only addressed human needs but mitigated vagaries of rainfall and fire hazards. Ancient Maya settlement patterns reflect a continuum of intensity, ranging from densely occupied upland ridges to sparsely inhabited lowlands. The spatial mosaic formed by the gradation between uplands, lowlands, and wetlands provided access to diverse habitats that facilitated living in and with the Maya forest. The forest today is a product of selection over generations, centuries, and millennia to fulfill everyday needs within the natural forest context [20–25].

## 2. Cycles from field to forest to field

Popular notions envision Maya populations outstripping their environment. This assumption seems to originate from interpretations of accounts by early conquistadors that eschewed appreciation of the Maya forest as a garden. The Spanish conquistadors' success in provisioning their armies and finding shelter in established towns belies perceptions of an unpopulated landscape. Acknowledging the evident bounty available to the conquistadors during their brutal conquest sets the stage for examining the resources available to support Maya civilization.

The economic value of the trees favored throughout the milpa cycle by Maya households and communities is noteworthy. Not only the dominant plants are useful (**Table 1**); a minimum examination of the literature shows nearly 160 named trees are favored for their utility. Each of these favored trees bear important qualities and fulfill significant purposes while generating habitats and maintaining biodiversity [7, 25–35].

Misunderstood and maligned as “shifting cultivation,” the milpa cycle is a complex web of landscape management inputs embedded in the forest itself (**Figure 4**). Resources were managed as a horizontal matrix with vertical



**Figure 3.**  
*The Dynamic Relationship of Forest and Field, Changing Over a Year, Decade, Generation, and Centuries. Credit: Kippy Nigh.*

variations, forming a complex mosaic created by heterogeneous spatial dimensions of the milpa forest garden cycle based on the opening of a milpa field that averages 1 hectare. At any one time, no more than one-fifth of the cultivated spaces, around 20%, are fields [12, 21]. The remaining lands, a minimum of 80%, are somewhere in the process of transforming from field to forest, and eventually cycling back to fields, in an organized and directed sequence of succession from annual crops to perennials.

| Common Name(s)                               | Scientific Name                 | Pollinator | Primary Use  |
|----------------------------------------------|---------------------------------|------------|--------------|
| Wild Mamey, Mamay Silvestre, Ts'om           | <i>Alseis yucatanensis</i>      | moths      | food         |
| Milady, Malerio, Sa'yuk                      | <i>Aspidosperma cruentumum</i>  | insects    | construction |
| Cohune, Corozo, Tutz/Mop                     | <i>Attalea cohune</i>           | insects    | oil          |
| Breadnut, Ramon, Yaxox                       | <i>Brosimum alicastrum</i>      | wind       | food         |
| Tourist tree, Gumbo limbo, Chaca             | <i>Bursera simaruba</i>         | bees       | medicine     |
| Give-and-take, Escoba                        | <i>Cryosophila stauracantha</i> | beetles    | production   |
| Monkey Fruit, Monkey Apple, Succotz          | <i>Licania platypus</i>         | moths      | food         |
| Black Cabbage Bark, Manchich, Manchiche      | <i>Lonchocarpus castilloi</i>   | insects    | construction |
| Zapodilla, Chico Zapote, Hach-ya             | <i>Manilkara zapota</i>         | bats       | food         |
| Wormwood, Jamaican Dog Wood, Jabin           | <i>Piscidia piscipula</i>       | bees       | poison       |
| Yellow Zapote, Mamey Cireula, Canistel,      | <i>Pouteria campechiana</i>     | insects    | food         |
| Zapotillo, Hoja Fina                         | <i>Pouteria reticulata</i>      | insects    | latex        |
| Bay leaf palm, Guano, Xa'an                  | <i>Sabal mauritiiformis</i>     | insects    | production   |
| Redwood, Palo Colorado, Chakte               | <i>Simira salvadorensis</i>     | moths      | instruments  |
| Hogplum, Jobo, Hobo                          | <i>Spondias mombin</i>          | insects    | food         |
| Mahogany, Caoba, Chacalte                    | <i>Swietenia macrophylla</i>    | insects    | construction |
| Mayflower, Maculiz, Hokab                    | <i>Tabebuia rosea</i>           | bees       | construction |
| Kinep, Guaya, Wayah                          | <i>Talisia oliviformis</i>      | bees       | food         |
| Fiddlewood, Blue Blossom, Flor Azul, Yax-nik | <i>Vitex gaumeri</i>            | bats       | construction |
| Drunken Baymen, Paragua, Tamay               | <i>Zuelania guidonia</i>        | bees       | medicine     |

**Table 1.**  
The top twenty dominant plants of the maya forest.

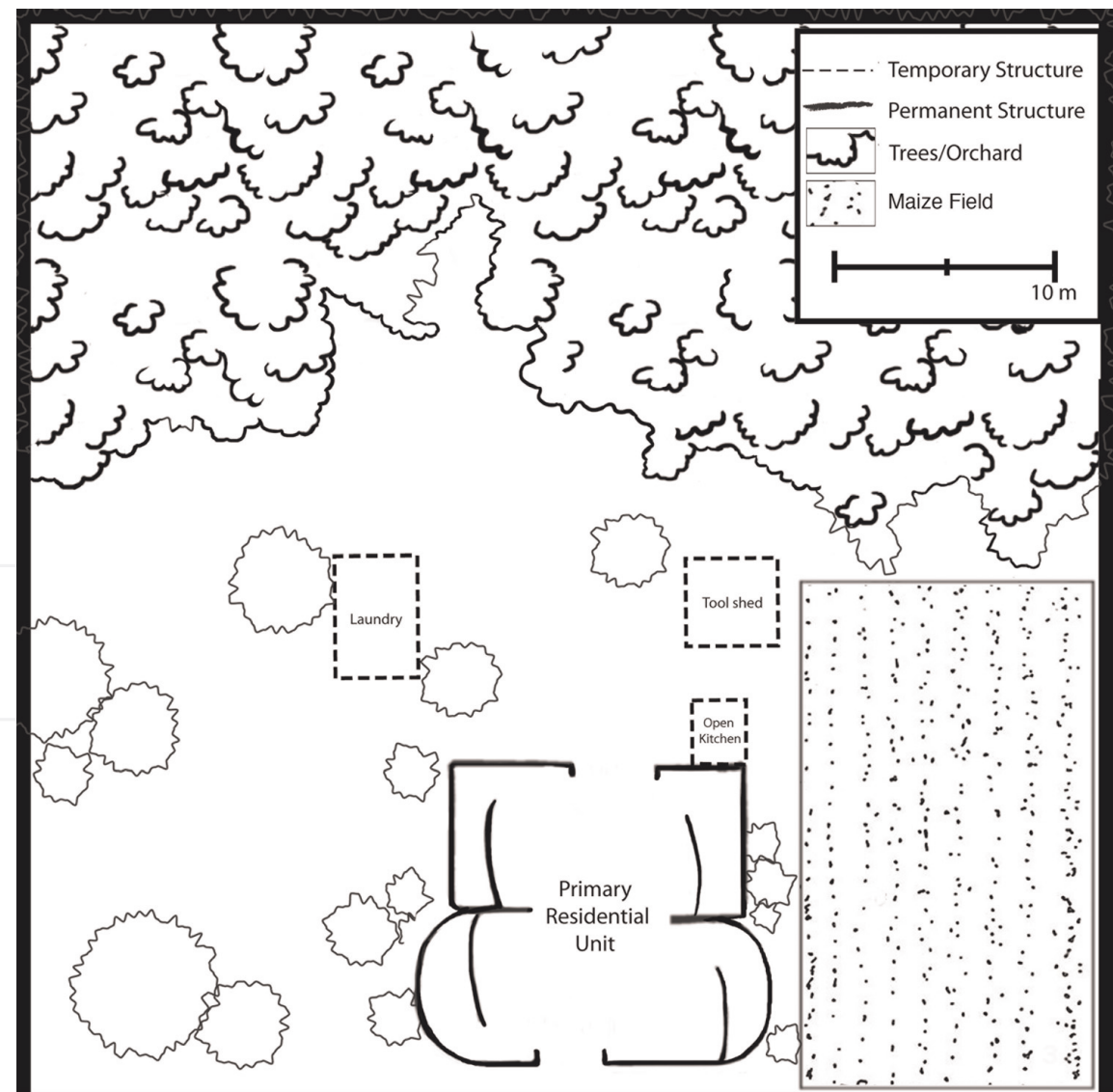


**Figure 4.**  
Lacandon Milpa showing Regeneration of Fields and Forest. Credit: James Nations.

This complex of interrelated plots is the Maya forest garden [36]. Tree fruits and animals inhabiting diverse habitats are an integral part of the Maya forest garden system. Drawing from ethnohistoric and contemporary accounts, the interspersed fields of the dynamic cycle is repetitive across space and time, consistent with traditional swidden sequences from around the world [37–39]. Building value through experimentation over generations, this regenerative cycle was as well-known to the Maya of the past as it is to their descendants today [40]. Our documentation of favored trees is a representation of the remarkable cultural impact of the Maya on this biodiversity hotspot [41, 42] and is an example of how interactions between humans and their environment can be constructive.

3. Daily needs in a tumpline economy

Transport in the Americas was primarily by foot and, in Mesoamerica, the tumpline was a dependable asset in transporting goods [43]. Reliance on human-powered

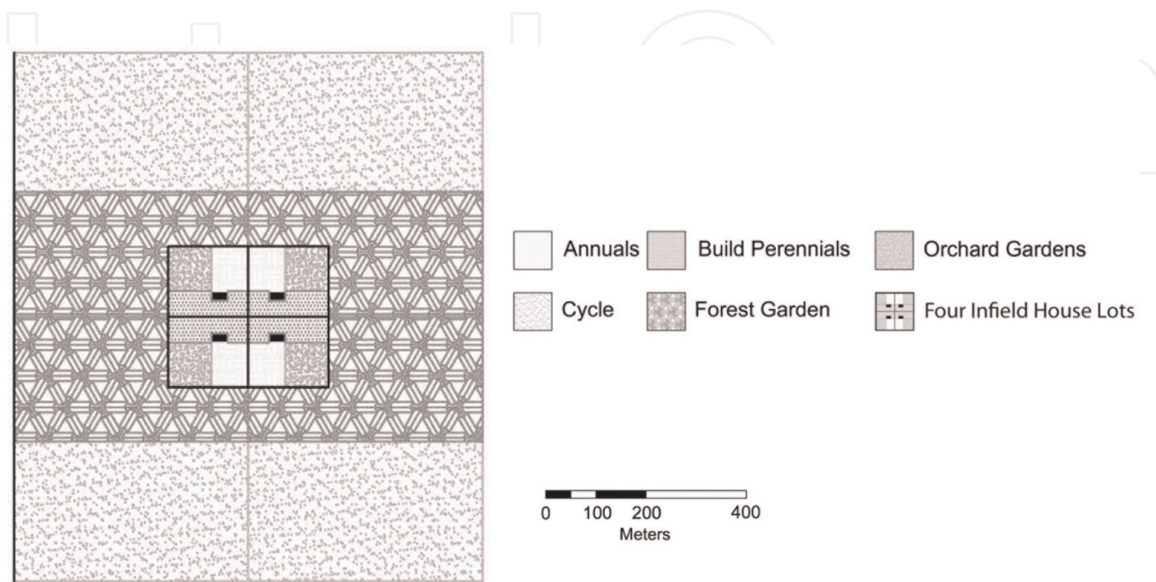


**Figure 5.**  
*Home Garden Infield with Domestic Structures, Milpa, and Forest Garden. Credit: MesoAmerican Research Center.*

transport technology meant household necessities would have to be accessible along a gradation of distance according to frequency of need: daily requirements would have to be most proximal, periodic needs would be at short range, while annual needs could be located farther afield. Still, a household's requisites could not be acquired from a distance farther than a day's round trip, nor something that would take much more than a household's extended network of resources to marshal.

Daily necessities, apart from food, would include firewood for cooking, ceramic production, production [35, 44, 45], and smoking foods. Meat protein from the diverse habitats of the milpa cycle [17, 18] and water from collection systems on the landscape were important [46, 47]. Managed home gardens infields are on average half a hectare (**Figure 5**) and extended habitats of the infield and the milpa cycle (**Figure 6**) would cover at least 5 hectares and provide periodic access to medicine and fruits, household products and furnishings such as baskets, utensils, containers, toys, and maintenance materials for leaky roofs, damaged posts, and floors. Annual schedules of maintenance would include refurbishing structures, orchard pruning, and construction of new buildings. All these would be the stock and trade of daily life.

Investments in the future are an important component of the favored trees we present here, with many attaining maturity in eight years and thriving over decades. Planting and nurturing these trees for the food, wood, latex, and fibers they provide would need to be scheduled to ensure routine access. Trees for fruit, spice, fodder, and fumigants would require preparation for dependable use. These could be developed in the annual field and cultivated as the field gives way to perennials. If you want an avocado, your tree might need to be 4 years old before it produces fruit, so forethought is required to ensure supply. Wood for construction varies in size, shape, and the component it is used to build; many trees will be not much larger than saplings for the construction of ordinary houses. Not all trees need attain significant girth—it is the properties that are amenable to the task. For example, only heartwood can be used in posts, while supporting cross members are gauged by the size of the structure, specific branching patterns are needed for roof supports, and so on with every facet of building. Knowledge of the properties of woods is held collectively and based on communities' needs, where the favoring of



**Figure 6.**  
*Infield-Outfield of the Milpa Cycle Land Use Model. Credit: MesoAmerican Research Center.*

specific trees would be essential. Latex for gum and glues must be managed to meet the myriad household uses that depend on sticking substances, including bandages, medicine, and mastication. Fibers are important for several household products, including weaving for clothing, mats, and walls, as well as hangers, hooks, and more expediate needs. In every case, knowledge of the trees, their multiple properties, and the skill in their propagation and use would be a vital component of household economies.

The remnant of the Maya forest today reflects past cycles of investments and decisions made annually by families over generations. The specific decisions made to enhance living needs, carried out over centuries, were destined to provide diverse resources. Decision making aimed to minimize risk and vulnerability to the whims of weather and the capriciousness of the rains. Every investment in the trees was designed to increase options and to hedge the challenges that were a daily fact of life.

#### **4. Significant Maya forest products**

Forest products derive from the landscape of the Maya lowlands, the same landscape that supplied the Spanish conquistadors with the necessities to support an invading army. The Maya derived their immediate needs for food, fodder, and fuel from the landscape, which they managed to conserve water, maintain access to goods and provide services. The importance of food and fuel is paramount in the Maya forest. Management skills and knowledge maintains soil fertility to enhance production from orchards and to increase field crop yields as well as habitats for hunted animals.

Cooking is intimately related to food consumption. Fuel woods are excluded from most economic botanical lists, yet data on the Maya show they are very selective in what they use for firewood [35, 48]. Not just any burnable material will do; fallen branches and logs are used but do not suffice. Ethnographic records show special preferences for size and burn qualities, such as strength, speed, flame size, and smoke. The nature of use—in hearths or kilns, or for smoking, charcoal production, and as kindling — is factored into fuel selection. Of 50 trees recorded for the Lacandon [35] that were used for tools, utensils, furniture, weapons, and house construction, twenty-two doubled as fuel sources, and many are the same woods recognized in archaeological middens [49]. Our discussions with forest gardeners reveal strategies developed to ensure consistent fuel availability, which is reflected in evidence from the archaeological record. Preferred fuel trees that respond well to re-sprouting can be coppiced to generate sprouted limbs of the appropriate size for cooking in hearths (Tzul personal communication) [50].

Household items of all sorts can be grown in home gardens and fields, and they can also be extracted from regenerating second growth and mature forests. Many forest products find their use in Maya houses as such varied items as bowls, colanders, cups, mixing utensils, baskets, brooms, and containers. Weaving required spindles, spindle whorls, and looms fabricated from forest materials. Fibers were of great importance for many household items, including strings, cordage, shoulder bags, hammocks, baskets, trivets, and covers. Colorants and dyes were also important resources from the forest. Children's toys include dolls, spinning tops, and rattles. Adornments for necklaces and head bands use a variety of seeds, not to mention feathers. Musical instruments were made of special woods, gourds, seeds, and fibers.

Today, as in the past, many plants have multiple uses, and medicine is among the most often identified (see [11]). Remedies derived from plants cover most ailments encountered in the household. Forests and gardens are the pharmaceutical commons, and familiarity with healing properties of plants, while a specialty of some, was shared among the community. Medicine/poisons are managed carefully and prescribed in doses scientifically refined by trial and error through time. Plants from the home garden and milpa, regenerating plots, and closed canopy forest all contribute to the pharmacopeia of the Maya.

Palms are abundant in the Maya forest; they are economically useful, providing resources, food, and products. They occupy the understories of closed canopy forests, respond as pioneers to the sun, and can be propagated for uses including building materials, cosmetics, food, fuel, materials for handicrafts, medicines, oils, rituals, roofs, and improvised shelters. Palms proliferate in response to human activities [51]. Cutting and burning, one of the most common of human interactions with the environment, result in a novel and domesticated landscape [52].

Much is made of hardwoods, the staples of international exotic wood markets. Mahogany and Spanish cedar, extensively harvested since the 19th century, were noted for their large height and diameter as well as their immense buttress supports. A product of ancient Maya forestry, trees reached these large sizes *only* in times of depopulation when the landscape went untended, particularly after the Spanish conquest when native populations plummeted [20]. With the neglect of the forest gardens, trees once harvested on a regular basis were left to grow for centuries before the lumbering industry exploited them in the 1700s. Mahogany is now on the CITES list [17], not because it is extinct, but because the time of growth is short. Given the way the lumber industry exploits forests today, it is unlikely they will ever achieve those enormous sizes again [45].

The utility of the Maya forest is rooted in Maya knowledge of products and the diverse habitats that can enhance availability of animals. We know that the Maya were habitual meat eaters based on the protein signature in human bones [53], and it has been demonstrated that there are no appreciable changes in the consumption of animals over time [16]. The same animals continue to be hunted from the same composite habitat of home gardens, regenerating perennials, mature forest, and ecotones from the earliest times of Maya settlement [17].

Forest habitats were also useful for honeybees and the Maya were expert beekeepers [54–56]. A forest with beehives has its own name in Mayan: *K'axil kab*. The scale of beekeeping must have been noteworthy at the time of European contact, as the Spanish colonists collected tribute in the form of honey and beeswax. Beekeeping artifacts and iconography are also evident in the archaeological record. It is worth noting the contribution of bee pollination as well, an important ecological service for the majority of the forest trees (see **Table 1**).

In this complex and dynamic process the ancient Maya cultivated their landscape in ways that prioritize usefulness and complement natural forest cycles. Collaborations with contemporary Maya farmers reveal a sophisticated knowledge base that contributes to the continued maintenance of the forest as a garden and is the base of our list of favored trees (Supplementary Appendix A). The average 20-year cycle is bound to the infield home gardens that are the hub of the outfield mosaic of annuals and perennials [57–60]. The cycle is characterized by a rotational system with consequences for nature and culture: open fields for traditional agricultural crops, secondary growth of perennials for household products, and completing the circuit with a closed canopy orchard forest covering the original cleared area. The land is then ready to repeat the cycle again.

## **5. Favored trees: management skills embedded in the Maya forest**

Built on the diversity of the milpa cycle, tree selection required opening gaps in the forest as part of swidden practice. This is not indiscriminate slashing and burning—skilled forest gardeners will select and grow with future investment in mind [57]. Burns are conducted with care and planning: a cleared trace is established at boundaries, cut saplings are encouraged to resprout, and specific trees will be favored and carefully tended to avoid the fires [36]. With a gap prepared for annuals over approximately four years, the favored trees will be managed to hasten the regenerative perennial component.

Succession comes with the building of perennials [36]. Many of the core trees destined for immediate use will be culled from these fields: firewood, medicine, house maintenance, and new animal habitat are benefits of this phase. Far from abandoned, these are the spaces that demand the most attention. Much time and investment is spent in building the perennial component of forest gardens. Nurturing trees for construction, culling poorly developed plants, identifying pests, and indeed hunting would be dominant activities in these developing landscapes. After eight years, forest gardens take on a more mature form, and tree production becomes the new focus. This is the time for investment in pruning, developing, and harvesting assets in the managed forest and enjoying fruits of the tended garden.

Lands cultivated in intense management cycles require skill, often in short supply, and labor investment, yet the advantage is the conservation of useful forest stands. These habitats are subject to the selection process emphasizing the needs of the populace and the conservation of the lands [36]. The advantage of this system is the accessibility of resources, it involves skill and knowledge for the prime returns. This means valuing the sophisticated abilities of Master forest gardeners and celebrating a community of good farmers. Care is taken to maintain valued trees in both intensively managed plots and native stands of trees. The objective is to balance short term requirements with long term needs. The challenge in contemporary settings is that the emphasis is on long-term stability and reducing risk as opposed to short term profit.

This time honored systems' greatest advantage is that the practice promotes food sovereignty and is action for environmental justice. The methods, strategies, and practices can best be learned as an apprentice, yet the Master forest gardeners are few and far between. These principles that are practiced by the Master forest gardeners confer benefits that builds soil fertility, reduces erosion, lowers temperature, conserves water, enhances biodiversity to care for people and our planet.

## **6. Developing a list of favored trees**

Considering the literature on favored trees in the clearing of milpas, we built a list to identify the uses, ecological service, and values inherent in these choices ([12], pp. 187–207). This article builds on that foundation with additional research by Grace Turner and validation of tree species at the Belize Herbarium with collaborator Hector Mai. We also worked with the encyclopedic knowledge of Master Forest Gardeners Narciso Torres and Alfonso Tzul and checked data with personal records of the first director of the *Vigilancia* of Tikal, Felipe Lanza [46]. We also verified references to favored plants in Balick and et al. [28], Cook [48], and Roys [61] and cross-referenced data with the Tikal ordination [62, 63]. Our collaborative effort has resulted in a master table of scientific and common names, herbarium references for validated

species, and generic uses of trees, which we present as a work in progress (Supplementary Appendix A).

Our research focuses on woody plants native to the Maya forest of the central Maya lowlands from El Pilar to Tikal (**Figure 1**). In our discussions with Master forest gardeners, we learned that plant identification could involve the smell, the sound of fruit dropping, the shape of leaves, the texture of bark, variation in buttresses, and even taste. We aimed to describe general uses, although multiple uses characterize many plants and medicine was a common theme. An exhaustive list of specific uses, while valuable, would require a more comprehensive inventory and will be considered for future research. Our presentation highlights the variety of the favored trees, their habits, and their general utility.

## 7. The Maya forest is a garden

Confusion about the value of the landscape, with milpa infields and dispersed outfields within the forest, has led to misrepresentations of the milpa cycle and its connection to natural forest regeneration. The preparation and use of fields within the forest, which forms the basis of a land cover matrix that once sustained large populations, has gone mostly unrecognized. The misinterpretation of the dynamic relationship of forest and fields further confounds this issue [36].

The milpa forest garden cycle has continuity from the conquest and colonial times to the present [12]. The landscape created by the milpa cycle embraces infield home gardens and diverse, accessible outfields interspersed among secondary growth, mature forest gardens, and closed canopy forests [64, 65]. The patchwork created by the field-to-forest cycle of the ethnohistoric and contemporary reports demonstrates how available resources were used to fulfill daily requisites of food, condiments, fiber, oils, fuel, gum, furnishings, supplies, medicine, toys, construction materials for buildings, household utensils for cooking, spinning, baskets, and habitat for animals. In short, all the everyday requirements of life. These resources can be projected back in time: the entire landscape with its soil characteristics, geological assets, and minerals were part of the environmental interaction to meet human needs in the past, and these have implications for the future.

To develop and maintain a landscape that reliably and dependably provides for everyday needs requires observation, skill, and knowledge. The Maya intensive agricultural and forestry system is based on dynamic engagement with natural processes, which minimized risk over time and maximized effects of labor and skill across space. Land cover practices engaged with natural processes ensured a vibrant conversion from annual crops to perennial trees. Forest garden practice mitigated effects of rainfall variation and built soil fertility with each phase of the high-performance cycle. The land cover provided by the forest-field mosaic conserved water and managed biodiversity, all while providing necessities for the populace (cf. [65]).

The milpa cycle, as a subsistence system, retains significant complexity and depends upon every aspect of the landscape, from the open forest gap through secondary growth gradients to the closed canopy forest. Without clearing to initiate the annual milpa, there would be no opportunity to select and stock the regenerating forest. This managed landscape results in integral perennial investments and creates the forest garden [26, 66, 67]. The horizontal and vertical distributions of forest products are sustained by the management of the milpa forest garden cycle, which depends on the knowledge and skill of the forest managers.

The Maya forest today is the cumulative result of selection across millennia, the product of trial and error experimentation, which demonstrates masterful long-term interactions with nature and the cultivation of biological “capital.” In the ancient world, managing forests for daily requisites was based on proximity to essential resources that fulfilled the diversity of daily, weekly, seasonal as well as ceremonial needs. Understanding the forest as a spatial composite is key to appreciating how the Maya managed and used resources.

The Mesoamerican and Maya forest, with 24,000 indigenous plants and associated habitats, has persisted as a hotspot of conservation today [42]. The biodiversity recognized in the contemporary Maya forest is the outcome of consistent and regular attention to selection emphasizing resources that sustained Maya life. With the imposition of ecological imperialism, the inappropriate and unsustainable “conventional” farming of cattle ranches and plowed fields is expanding at the expense of the forest to maximize short-term profits. All the while, the greatest threat to the value of the Maya forest is the loss of the active management of traditional Maya farmers.

Key Websites for Tropical Plants

|                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="https://www.tropicos.org">https://www.tropicos.org</a>                                                                                                                                    |
| <a href="http://www.worldfloraonline.org/">http://www.worldfloraonline.org/</a>                                                                                                                    |
| <a href="https://www.cabi.org">https://www.cabi.org</a>                                                                                                                                            |
| <a href="https://plants.sc.egov.usda.gov/java/">https://plants.sc.egov.usda.gov/java/</a>                                                                                                          |
| <a href="http://www.maya-ethnobotany.org">http://www.maya-ethnobotany.org</a>                                                                                                                      |
| <a href="https://www.backyardnature.net">https://www.backyardnature.net</a>                                                                                                                        |
| <a href="http://powo.science.kew.org">http://powo.science.kew.org</a>                                                                                                                              |
| <a href="http://swbiodiversity.org/seinet/">http://swbiodiversity.org/seinet/</a>                                                                                                                  |
| <a href="https://www.fnps.org">https://www.fnps.org</a>                                                                                                                                            |
| <a href="https://www.wildflower.org/plants/">https://www.wildflower.org/plants/</a>                                                                                                                |
| <a href="https://www.regionalconservation.org">https://www.regionalconservation.org</a>                                                                                                            |
| <a href="https://www.inaturalist.org">https://www.inaturalist.org</a>                                                                                                                              |
| <a href="https://www.rareflora.com">https://www.rareflora.com</a>                                                                                                                                  |
| <a href="https://www.itis.gov">https://www.itis.gov</a>                                                                                                                                            |
| <a href="https://toptropicals.com/catalog">https://toptropicals.com/catalog</a>                                                                                                                    |
| <a href="https://www.rainforest-alliance.org">https://www.rainforest-alliance.org</a>                                                                                                              |
| <a href="http://www.palmpedia.net/wiki/Main_Page">http://www.palmpedia.net/wiki/Main_Page</a>                                                                                                      |
| <a href="https://www.cicy.mx/sitios/flora%20digital/indice_busqueda.php">https://www.cicy.mx/sitios/flora%20digital/indice_busqueda.php</a> <a href="mailto:herbario@cicy.mx">herbario@cicy.mx</a> |
| <a href="https://mayaforestgardeners.org/">https://mayaforestgardeners.org/</a>                                                                                                                    |

Acknowledgements

Our foray into the favored trees of the Maya has demonstrated how little we know. Our list, compiled and discussed with Master Forest Gardeners, is woefully incomplete and barely captures the essence of the values we have glimpsed. The compilation

starts from the literature, not from our citizen scientists, consequently it can only be a reflection of what researchers, not Master Maya Forest Gardeners, can identify. Narciso Torres and Alfonso Tzul literally spent hours across many days with us discussing the compilation of names we had gathered. Can you imagine if we began with their list? It is a world of possibilities and we must thank them for their magnanimous nature to share what little we may grasp. We must also thank our research team, especially Sherman Horn, for their salient comments and suggestions.

## Appendix A: Favored Trees

The Maya forest is a garden supplying all the requirements of everyday life. A search through the literature on Maya land use, the milpa cycle and plant characteristics, reveals a conservation ethic that bears on a world of uses that include the following: beverage, construction, dye, fiber, food, foraging, fuel, fumigant, furniture, gum, latex, medicine, oil, ornament, poison, products, resin, ritual, smoking, spice, tannin. The dominant trees of the Maya forest are shown in bold.

The online link for the supplementary table Appendix A: <https://cdn.intechopen.com/public/docs/266251.xlsx>

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## References

- [1] Campbell DG et al. The Feral Forests of the Eastern Petén. In: Balée W, Erickson C, editors. *Time and Complexity in the Neotropical Lowlands: Studies in Historical Ecology*. New York: Columbia University Press; 2006. pp. 21-55
- [2] Ford A. The Maya Forest: A domesticated landscape. In: Hutson SR, Arden T, editors. *The Maya World*. London: Routledge; 2020
- [3] Ross NJ. Modern tree species composition reflects ancient Maya “Forest Gardens” in Northwest Belize. *Ecological Applications*. 2011;**21**:75-84
- [4] Altieri MA, Toledo VM. Natural resource management among small-scale farmers in semi-arid lands; building on traditional knowledge and agroecology. *Annals of Arid Zone*. 2005;**44**:365-385
- [5] Kellman M, Tackaberry R. In: Richards K, Series RPE, editors. *Tropical Environments: The Functioning and Management of Tropical Ecosystems*. New York: Routledge; 1997. p. 380
- [6] Martínez-Reyes JE. *Moral Ecology of a Forest: The Nature Industry and Maya Post-Conservation*. Tucson: University of Arizona Press; 2016
- [7] McNeil CL, Burney DA, Burney LP. Evidence disputing deforestation as the cause for the collapse of the ancient Maya Polity of Copan, Honduras. *PNAS*. 2010;**107**:1017-1022
- [8] Steggerda MW. Some Ethnological Data Concerning One Hundred Yucatan Plants. *Bureau of American Ethnology, Bulletin*. 1943;**138**
- [9] McNeil CL. Deforestation, agroforestry, and sustainable land management practices among the classic period Maya. *Quaternary International*. 2012;**249**:19-30
- [10] Wilken GC. *Good Farmers: Traditional Agricultural Resource Management in México and Central America*. Berkeley, California: University of California Press; 1987
- [11] Ford A. Dominant plants of the Maya forest and gardens of El Pilar: Implications for Paleoenvironmental reconstructions. *Journal of Ethnobiology*. 2008;**28**(2):179-199
- [12] Ford A, Nigh R. *The Maya Forest Garden: Eight Millennia of Sustainable Cultivation in the Tropical Woodlands*. Santa Rosa, California: Left Coast Press; 2015
- [13] Fedick SL. Maya cornucopia indigenous food plants of the Maya lowlands. In: Freidel DA, Masson MA, editors. *The Real Business of Ancient Maya Economies*. Gainesville: University Press of Florida; 2020
- [14] Fedick SL, Santiago LS. Large variation in availability of maya food plant sources during ancient droughts. *PNAS*. 2022;**119**
- [15] Morell-Hart S. Plant foodstuffs of the ancient Maya: Agents and matter, medium and message. In: Arden T, editor. *Her Cup for Sweet Cacao: Food in Ancient Maya Society*. Austin: University of Texas Press; 2021. pp. 124-160
- [16] Emery KF. Assessing the impact of ancient Maya animal use. *Journal for Nature Conservation*. 2007;**15**:184-195
- [17] Emery KF, Thornton EK. Zooarchaeological habitat analysis of

ancient Maya landscape changes. *Journal of Ethnobiology*. 2008;**28**:154-178

[18] Emery KF, Thornton EK. Using animal remains to reconstruct ancient landscapes and climate in the central and Southern Maya Lowlands. In: Lefèvre C, editor. *Proceedings of the General Session of the 11th International Council for Archaeozoology Conference* (Paris, 23-28 August 2010). Oxford, UK: Archaeopress; 2012. pp. 203-225

[19] Emery KF, Thornton EK. Tracking climate change in the ancient Maya world through Zooarchaeological habitat analyses. In: Iannone G, editor. *The Great Maya Droughts in Cultural Context: Case Studies in Resilience and Vulnerability*. Boulder, Colorado: University Press of Colorado; 2014. pp. 301-331

[20] Folan WJ, Fletcher LA, Kintz ER. Fruit, fiber, bark, and resin: Social Organization of a Maya urban center. *Science*. 1979;**204**:697-701

[21] Ford A, Clarke KC. Linking the past and present of the ancient Maya: Lowland use, population distribution, and density in the late classic. In: Isendahl C, Stump D, editors. *Handbook of Historical Ecology and Applied Archaeology*. Oxford, England: Oxford University Press; 2019. pp. 156-183. DOI: 10.1093/oxfordhb/9780199672691.001.0001/oxfordhb-9780199672691-e-33

[22] Pompa AG, Kaus A. From pre-Hispanic to future conservation alternatives: Lessons from Mexico. *Proceedings of the National Academy of Sciences*. 1999;**96**:5982-5986

[23] Guariguata MR. What are the knowledge gaps for better understanding of forest regrowth in tropical human modified landscapes? In: *The Role of*

*Tropical Secondary Forests in Conservation and Restoration* (A joint webinar sponsored by the Society for Ecological Restoration and the Association for Tropical Biology and Conservation). 2017 Available from: <https://tropicalbiology.org/career-development/webinars/role-secondary-forests/>

[24] Toledo VM. La Vía Ecológico-campesina de Desarrollo: Una Alternativa para la Selva de Chiapas. *La Jornada del Campo*. 1994;**23**:4-6

[25] Toledo VM. Lessons from the Maya. *Bioscience*. 2005;**37**:377-378

[26] Atran S, Edilberto UE. Classification of useful plants among the Northern Peten Maya (Itzaj). In: White CD, editor. *Reconstructing Ancient Maya Diet*. Salt Lake City, Utah: University of Utah Press; 1999. pp. 19-59

[27] Balick MJ, Beck HT. *Useful Palms of the World: A synoptic Bibliography*. New York: Columbia University Press; 1990

[28] Balick MJ, Nee MH, Atha DE. Checklist of the vascular plants of Belize with common names and uses. In: Buck WR, editor. *Memoirs of the New York Botanical Garden*. Bronx, New York: The New York Botanical Garden Press; 2000. p. 246

[29] Morehart CT, Lentz DL, Prufer KM. Wood of the Gods: The Ritual Use of Pine (*Pinus* spp.) by the Ancient Lowland Maya. *Latin American Antiquity*. 2005;**16**:255-274

[30] Nations JD, K'in Jose Valenzuela C. *Maya Lacandon- el Idioma y el Medio Ambiente*. Createspace Independent Publishing Platform; 2017

[31] Thompson KP, Hood A, Cavallaro D, Lentz DL. *Connecting contemporary*

ecology and ethnobotany to ancient plant use practices of the Maya at Tikal. In: Lentz DL, Dunning NP, Scarborough VL, editors. *Tikal: Paleoecology of an Ancient Maya City*. New York: Cambridge University Press; 2015), chap. 7. pp. 124-151

[32] Toledo VM, Ortiz Espejel B, Cortés L, Moguel P, Ordoñez MDJ. The Multiple Use of Tropical Forests by Indigenous Peoples in México: A Case of Adaptive Management. *Conservation Ecology*. 2003;7:9

[33] Hernández Xolocotzi E, Bello Baltazar E, Levy Tacher SI. *La Milpa en Yucatán: Un Sistema de Producción Agrícola Tradicional*. Vol. 1 y 2. México: Colegio de Postgraduados; 1995

[34] Voorhies B. An ecological model of the early Maya of the central lowlands. In: Flannery KV, editor. *Maya Subsistence: Studies in Memory of Dennis Edward Puleston*. Academic Press: New York; 1982. pp. 65-95

[35] Arnold DE. *Maya Potters' Indigenous Knowledge Cognition, Engagement, and Practice*. Boulder: University Press of Colorado; 2018

[36] Ford A, III SH, Crimmel T, Tran J. Conserving the American Tropics: Exploring the cropscape of the ancient Maya. *Technology's Stories*. 2021;9. DOI: 10.15763/jou.ts.12021.15703.15723.15701

[37] Conklin HC. An ethnoecological approach to shifting agriculture. In: Wagner PL, Mikesell MW, editors. *Readings in Cultural Geography*. Chicago: University of Chicago Press; 1971. pp. 457-464

[38] Dove M. Theories of swidden agriculture and the political economy of ignorance. *Agroforestry Systems*. 1983;1: 85-99

[39] Geertz C. *Agricultural Involution: The Processes of Ecological Change in Indonesia*. Berkeley, California: University of California Press; 1963. p. 170

[40] Terán S, Rasmussen CH. Genetic diversity and agricultural strategy in 16th century and present-day Yucatecan Milpa agriculture. *Biodiversity and Conservation*. 1995;4:363-381

[41] Mittermeier RA, Myers N, Mittermeier CG. *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. CEMEX: México; 2000. p. 430

[42] TNC, *Maya Forest*. (2022).

[43] Hassig R. *Trade, TRIBUTE, and Transportation: The Sixteenth-Century Political Economy of the Valley of Mexico, The Civilization of the American Indian*. Norman: University of Oklahoma; 1985 xvi, 364 p. : ill. ; 322 cm

[44] Metzger DG, Williams GE. Some procedures and results in the study of native categories: Tzeltal "Firewood". *American Anthropologist*. 1966;68: 389-407

[45] Snook LK, Capitanio R. *Restoring Valuable Diversity Through Patch Clearcuts in Tropical Forests: Slash and Burn is Best*. Bioversity International; 2012 Available from: [http://elti.fesprojects.net/ISTF%20Conference%202012/laura\\_snook\\_istfconference2012.pdf](http://elti.fesprojects.net/ISTF%20Conference%202012/laura_snook_istfconference2012.pdf)

[46] Ford A. Critical resource control and the Rise of the classic period Maya. In: Fedick SL, editor. *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*. Salt Lake City, Utah: University of Utah Press; 1996. pp. 297-303

[47] Scarborough VL. *Water management in the Southern Maya*

lowlands: An accretive model for the engineered landscape. In: Scarborough VL, Isaac BL, editors. *Economic Aspects of Water Management in the Prehispanic New World* Greenwich. Vol. 7. Greenwich, Connecticut: JAI Press; 1993. pp. 17-69

[48] Cook S. *The Forest of the Lacandon Maya: An Ethnobotanical Guide*. New York: Springer; 2016

[49] Dussol L, Elliott M, Michelet D, Nondédéo P. Ancient Maya silviculture of breadnut (*Brosimum alicastrum* Sw.) and sapodilla (*Manilkara zapota* (L.) P. Royen) at Naachtun (Guatemala): A reconstruction based on charcoal analysis. *Quaternary International*. 2017; **457**:29-42

[50] Tzul A. *Personal Communication Related to His Boyhood*. Cayo, Belize: San Ignacio; 2020

[51] Beckerman S. The use of palms by the Barí Indians of the Maracaibo Basin. *Principes-Journal of the Palm Society*. 1977;**21**:143-154

[52] Balick MJ, Arvigo R. *Messages from the Gods: A Guide to the Useful Plants of Belize*. New York: Oxford University Press; 2015. p. 539

[53] Scherer AK, Wright LE, Yoder CJ. Bioarchaeological evidence for social and temporal differences in diet at Piedras Negras, Guatemala. *Latin American Antiquity*. 2007;**18**:85-104

[54] B. Bianco, R. T. Alexander, G. Rayson, "Beekeeping practices in modern and ancient Yucatan: Going from the known to the unknown" in *The Value of Things: Prehistoric to Contemporary Commodities in the Maya Region*, J. P. M. A., T. H. Guderjan, Ed. University of Arizona Press, Tucson, Tucson, 2017), pp. 87-103.

[55] K. K. Hirst, *Ancient Maya Beekeeping: The Stingless Bee in Pre-Columbian America*. ThoughtCo. Available from: <https://www.thoughtco.com/ancient-maya-beekeeping-169364>. 2018

[56] Imre D. *Ancient Maya Beekeeping*. University of Michigan Undergraduate Research Journal. 2010;**7**:42-50

[57] Fisher C. The role of infield agriculture in Maya cities. *Journal of Anthropological Archaeology*. 2014;**36**: 196-210

[58] Gasco J. 'Le Da Alegría Tener Flores' Homegardens in the Soconusco Region of Chiapas. Mexico. *Journal of Ethnobiology*. 2008;**28**:259-277

[59] Netting RM. *Agrarian Ecology*. *Annual Review of Anthropology*. 1974;**3**: 21-56

[60] Pulido MT, Caballero J. The impact of shifting agriculture on the availability of nontimber forest products: the example of *Sabal yapa* in the Maya lowlands of Mexico. *Forest Ecology and Management*. 2006;**222**:399-409

[61] Roys RL. *The Ethno-Botany of the Maya*. In: Germani G, editor. *Middle American Research Series*. Vol. 2. New Orleans, LA: The Department of Middle American Research, Tulane University; 1931. p. 380

[62] Schulze MD, Whitacre DF. A Classification and Ordination of The Tree Community of Tikal National Park, Petén, Guatemala. *Bulletin of the Florida Museum of Natural History*. 1999;**41**: 169-297

[63] Martínez E, Galindo-Leal C. *La Vegetación De Calakmul, Campeche, México: Clasificación, Descripción y*

Distribución. Boletín de la Sociedad  
Botánica de México. 2002;71:7-32

[64] F. Bongers (2017) Why secondary forests? Why now? in The Role of Tropical Secondary Forests in Conservation and Restoration (A joint webinar sponsored by the Society for Ecological Restoration and the Association for Tropical Biology and Conservation. Available form: <https://tropicalbiology.org/career-development/webinars/role-secondary-forests/>).

[65] Chazdon RL. Second Growth: The Promise of Tropical Forest Regeneration in an Age of Deforestation. Chicago: University of Chicago Press; 2014. p. 472

[66] Atran S. Anthropogenic vegetation: A garden experiment in the Maya lowlands. In: Gómez-Pompa A, Allen MF, Fedick SL, Jimenez-Osornio JJ, editors. The Lowland Maya Area: Three Millennia at the Human-Wildland Interface. New York: Food Products Press; 2003. pp. 517-532

[67] McKillop H. Ancient Maya tree cropping: A viable subsistence adaption for the Island Maya. *Ancient Mesoamerica*. 1994:129-140