CHAPTER 4

AMAZONIAN HOMEGARDENS: THEIR ETHNOHISTORY AND POTENTIAL CONTRIBUTION TO AGROFORESTRY DEVELOPMENT

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Abstract. This chapter reviews how homegardens and a number of other traditional agricultural practices survived the aftermath of European conquest of Amazonia. The historical development of homegardens in Amazonia began with the evolution of agriculture and domestication of trees in prehistoric times, followed by the development of cultural complexes along the Amazon River and its main tributaries. These traditional societies, characterized by rich material culture and well-developed agricultural systems, were decimated by the combination of epidemics, wars and slavery that accompanied the European conquest. Yet, the homegardens survived in Amazonia, and today they represent the reorganization of the original indigenous practices within the context of the upheaval and changes brought by colonization and market economies, including the incorporation of introduced Asian fruit trees. Although homegardens near urban centers may provide income, in rural areas they are important chiefly for household subsistence. They are often the focus of experimentation with new tree species and cultivation techniques, and thus have the potential to contribute to the development of other agroforestry systems, and to extension efforts that seek alternatives for agricultural development in Amazonia.

1. INTRODUCTION

The local and regional diversity of Amazonian homegardens is best understood by studying their origins and how they have been influenced by the socioeconomic and

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cultural forces that have shaped social organization and subsistence practices in the region, from prehistoric times to the present. This historical development begins with the evolution of agriculture and the domestication of trees in prehistoric times, followed by the emergence of complex cultures or chiefdoms along the main rivers, described by the first European explorers as exhibiting elaborate material culture and agricultural systems (Carvajal, 1542; Acuña, 1639). Although European conquest subsequently decimated these societies through a combination of epidemics, wars and slavery, as this chapter will show, a number of their agricultural practices, including homegardens, survived.

The *traditional* (i.e., prior to any interventions by research/extension agencies) homegardens of Amazonia represent a dynamic equilibrium of these original indigenous practices with the new social order and scenario created by the process of colonization. Included in this process was the incorporation of many Asian fruit trees introduced by the Europeans. The culture of traditional river-edge inhabitants, known as *caboclos* (in Brazil) or *ribereños* (in Peru) represents the fusion and synthesis resulting from this historical process, and homegardens today are an integral part of life throughout Amazonia.

Some of these homegardens and their ethnoecology have been formally described in many scientific publications (Denevan and Padoch, 1987; Padoch and de Jong, 1991; Smith, 1996; 1999; Coomes and Burt, 1997; Lamont et al., 1999; Denevan, 2002; Coomes and Ban, 2004), including some dissertations (Bahri, 1992), Annals of the Brazilian Agroforestry Congresses, and other such records (e.g., Miller, 1994; van Leeuwen and Gomes, 1995; Rosa et al., 1998a; 1998b; 1998c). Although a portion of this literature limits its scope to descriptions or lists of species found in the homegardens, some of these evaluate the factors determining choice of species, their management, and how proximity of markets influence these (e.g., Lamont et al., 1999). Based on this body of literature, and the personal experience of the authors in Amazonia, this chapter will attempt to reach some general conclusions as to the historical and cultural importance of homegardens, and how this can be linked to the underlying processes of the relationship between humans and cultivated trees. An understanding of this relationship is essential for evaluating the potential contribution of homegardens to extension efforts that seek alternatives for agricultural development in Amazonia, and some suggestions will be made along this line.

2. ETHNOHISTORY OF HOMEGARDENS IN AMAZONIA

2.1. Pre-historical development of agriculture and homegardens in Amazonia

Archeological evidence from the lowland neotropics in Colombia, Ecuador, Peru, and Mesoamerica indicates that between 10 000 and 8600 b.p. (before present) horticulture emphasizing both native tubers and seed plants was taking place outside Amazonia (Piperno and Pearsall, 1998; Piperno et al., 2000; Smith, 2001). However, in a site in Rondônia, in western Brazilian Amazonia, where human occupation by hunter-gatherers dates back to 9000 b.p., vestiges of agricultural activity, in the form

of processing utensils, only begin to appear around 4500 b.p. (Miller, 1992). Lathrap (1977) argues that the earliest agriculture in Amazonia was probably adjacent to dwellings, along or near rivers in forests that did not require frequent clearing. At some moment, native fruit trees were domesticated and incorporated into these prehistoric agricultural systems. This process may have occurred initially through the 'dump heap' (*sensu* Anderson, 1952) or incidental route to domestication, when seeds of edible fruits collected in the forest were discarded near dwellings. Although little information is available on the sequence of domestication for neotropical tree crops, it is likely that this was concurrent with the domestication of root-crops, as the maintenance of gardens near dwellings would have provided an ideal location for the discarded seeds of useful tree species to germinate and grow. The recognition and management of such 'volunteers' would have been the first step along the road to their domestication.

By 3000 to 2000 b.p., agricultural development made possible the existence of larger villages of many hectares on the middle and lower Orinoco River in Venezuela, and by 2000 years ago, large, socially stratified chiefdoms were thriving along the principal rivers of Amazonia. There is evidence of crop domestication and diffusion from this period of Amazonian history. For example, Salick (1992) has found that the domestication and exchange of cocona (*Solanum sessiliflorum*), common to Western Amazonian homegardens today, may have begun as long as 2000 years before present. When the first European explorers arrived in Amazonia in the 16th century, large population complexes, exhibiting an elaborate material culture and ceremonial art, occupied the margins of the main rivers, with links to surrounding regions through extensive trade networks (Roosevelt, 1994). From the description by Jesuit friar Gaspar de Carvajal, in his account of the first European exploration of Amazon in 1541–`42, we know that part of this cultural development consisted of agricultural systems based on a great variety of cultivated plants, including fruit trees, and the storage of various foods such as cassava (*Manihot esculenta*), maize (*Zea mays*), dried fish, and penned river turtles (Carvajal, 1542). Although the existence of some sort of homegarden is clear in these historical accounts, little detail is provided on the nature of these indigenous agroforestry systems. Carvajal, for example, mentions only that "much fruit of all kinds" was found in one village, and that fruit trees were planted on either sides of the road leading to another village (Carvajal, 1542). In all, at least 138 species of plants are thought to have been under cultivation or management at the time of European arrival in Amazonia, of which 68% were trees or woody perennials (Clement, 1999a). Besides the species mentioned in historical accounts, it is possible that in pre-Columbian times many more species were also cultivated, or were in a state of incipient domestication. A number of commonly cultivated Amazonian fruit trees have the characteristics of long periods of selection and genetic improvement. Clement (1989; 1999b) suggests the existence of a pre-Columbian center of crop diversity in Western Amazonia, based on the genetic diversity of fruit tree domesticates. In terms of their manipulation of plant resources, pre-Columbian cultures in Amazonia appear to have operated along a gradient of domestication, with plants fully domesticated and reliant on human care for their dispersal and survival at one extreme, as is the case of the peach palm (*Bactris gasipaes*). At the

other extreme of this gradient were those wild plants that may be found in greater than normal concentrations around ancient village sites, as a result of agricultural clearing and burning, with the possible favoring of their regeneration, but which do not exhibit any apparent genetic differentiation from their wild counterparts. Between these extremes are found a number of interesting and useful plants, suggesting that an active process of genetic selection and domestication was taking place in pre-Columbian Amazonia. An example of how this process may have occurred (and continues to occur) is described by Schroth et al. (2004), for the palm *Astrocaryum tucuma* in the Manaus region. Nevertheless, for the most part, the continuing domestication of wild species was truncated by the European conquest.

In less than 200 years after the events described in Carvajal's report (Carvajal, 1542), the great chiefdoms along the Amazon had succumbed to epidemics of imported diseases such as smallpox and measles, wars, and enslavement. Their sophisticated culture and political and trade networks collapsed, and large stretches of the Amazon River and its tributaries were totally deserted (Daniel, 1776).

Despite the decimation of native Amazonian populations that occurred during European conquest, with an ensuing loss of agrobiodiversity, many elements of their agricultural and agroforestry systems survived and can be seen among the modern tribal groups. The agroforestry practices of some of the tribal peoples in Amazonia, reviewed in Miller and Nair (2006), range from the cultivation of fruit trees and other useful plants around dwellings (homegardens), to the incorporation of trees in agricultural fields and fallows, which may involve practices such as actively planting or managing useful tree species or sparing seedlings that regenerate naturally. The homegarden of fruit trees, condiments and medicinal plants may grade into a belt of fruit trees surrounding a village, fruit trees interspersed with field crops, orchards of mixed fruit trees, and fallows of forest species enriched with fruit trees – these last mentioned configurations having been termed "swidden-fallow agroforestry" (Denevan and Padoch, 1987; Denevan, 2002). Although there are exceptions, as in the case of tribes with a very rudimentary agriculture, for the most part, homegardens can be considered as an important component of the subsistence technologies and cultural knowledge of Amazonian tribes.

Whether the specific cultivation methods employed by contemporary indigenous groups are the same as those of their pre-colonial ancestors is a difficult question to answer. Nevertheless, it is probable that the agroforestry systems practiced by indigenous peoples as well as the *caboclos* and *ribereños* are direct descendants of the systems in existence prior to European arrival, with the addition of a number of exotic species of fruit trees. This contribution of exotic species introduced by Europeans is discussed in the context of the ethnohistory of *caboclo* and *ribereño* culture, the subject of the following section.

2.2. Ethnohistory of caboclo *and* ribereño *culture and homegardens in Amazonia*

Although the use of the term *caboclo* has been criticized due to its negative social connotations (Lima, 1999), it is difficult to substitute, as it encompasses both colloquial as well as academic meanings in Brazil, and is a broad descriptor of a regional form of life and natural resource use. While modern-day tribal groups of

Amazonia in most cases represent the fragments of populations and cultures that escaped to survive and regroup following the colonial holocaust, *caboclo* society in Brazil or *ribereño* society in Peru and their cultures are the result of the fusion of the remnants of the native populations, decimated during colonization, with European and African racial and cultural elements (Padoch and Pinedo-Vasquez, 2001; Ribeiro, 1997). In this process, agricultural, social, economic, and belief systems were reconfigured and reconstructed upon an existing knowledge base of ecological systems and subsistence practices, with the addition of new tools and technologies. Key players in this process were the Catholic missionaries in Amazonia. As allies to the colonial economic system, they had a major role in providing an ideology for the domination of the native populations and their transformation into a labor force. Along with the forts, missions were fundamental elements in guaranteeing the domination of the region by the Portuguese from 1650 – 1750, and allowing the functioning of commerce (Alves-Filho et al., 2005).

Despite the superiority of Portuguese armaments, the native peoples did not submit easily to Portuguese attempts to enslave or otherwise conscript them as agricultural workers growing subsistence and commercial crops, collectors of forest products (such as cacao, *Theobroma cacao*), in the construction of public works, and other forms of labor, without which the colonial economy in Brazil would have collapsed (Alves-Filho et al., 2005). In response, they waged war, rebelled in villages and missions, deserted from royal services, massacred when possible their enemies, and even made peace treaties when convenient (Santos, 2002). Elsewhere in Amazonia, natives also put up fierce resistance, lasting well into the republican period of the former Spanish colonies, especially in Peru and Colombia (San Ramon, 1994; Stanfield, 1998; Rios, 2001).

The search for cacao using Indian labor, primarily from stands of wild or feral trees, motivated the Portuguese to range far upriver, leading Portuguese incursions west into Spanish territory (now Peru) to kidnap Indians on the Marañon River during 1686 – 1723 (Edmundson, 1922). By 1730, cacao had become the region's dominant export, remaining so for more than a century (Alden, 1976; Hemming, 1987). Cacao gathering expeditions had ceased by 1750 and cacao was being cultivated in plantations along the Amazon. Farmers grew seedlings on raised beds for a year, and then transplanted them into their cassava fields, where banana plants (*Musa* sp.) had been previously planted to provide shade. Native fruit trees, along with introduced species, such as orange (*Citrus sinensis*) and avocado (*Persea americana*), were also interplanted with cacao, as it was known that cacao produced better in shade (Daniel, 1776). Cacao appears to have been an important, if not the principal, economic element of the agroforestry systems of that time. By the mid-1800s, another exotic species, coffee (*Coffea arabica*), was one of the main agricultural exports of the region, along with cotton (*Gossypium* sp.), cacao, guaraná (*Paulinia cupana*), and tobacco (*Nicotiana tabacum*) (Amazonas, 1852).

By 1875, the rising demand for rubber, an important material for the Industrial Revolution, led to an economic boom in Amazonia. Rubber, extracted from the forest tree *Hevea brasiliensis*, had by 1880 become the third most important export in Brazil and Peru (Stanfield, 1998; Homma, 2003). The *caboclo* population, concentrated on the Amazon and Solimões Rivers, spread out through the entire

basin in search of rubber trees. A mixture of *caboclo*, *mestizo*, European, and indigenous (tribal) gatherers tapped the forests of Peru, Colombia, and Bolivia; and Manaus, Belém, and Iquitos grew into the principal commerce centers along the Amazon River. The boom attracted many migrants as well as absorbing the local labor force, with the result that agricultural production in Amazonia dropped sharply (Ribeiro, 1997; Stanfield, 1998). The rubber boom also brought disastrous consequences to the remaining forest tribes, as rubber tappers penetrated even the most distant headwaters. The atrocities committed against the Indians and their conscription as forced labor were so widespread that they attracted international attention (Renard-Casevitz, 1992; Stanfield, 1998). With the drop in agricultural production, food prices soared. Tribal societies involved in the trade could do little farming, suffered from severe hunger, and often lost their lands to rubber tappers (Stanfield, 1998). Where they survived, homegardens undoubtedly played a key role in providing food for rural inhabitants, regardless of their ethnicity.

The crash in rubber prices returned Amazonia to the state of an economic backwater by the end of the First World War (Homma, 2003). Indigenous knowledge, so important to the European and *mestizo* efforts to cultivate and exploit the most economically lucrative resources of the region, lay dying in the form of abandoned fields across the wide swaths of Amazon basin. According to Denevan (2002), homegardens in Amazonia became less important and poorly developed after the arrival of Europeans, mostly because indigenous villages changed their locations much more frequently than they did in the past, yet another consequence of this tragic history.

2.3. Transformation of traditional agriculture during colonial times

Although the Portuguese introduced a number of new crops to Amazonia, such as sugarcane (*Saccharum officinarum*), indigo (*Indigofera indica*), and rice (*Oryza sativa*), as well as domestic animals, indigenous agricultural practices remained the basis for subsistence, and they were also adapted for the production of commercial crops such as cacao. At the same time that technology guaranteed Portuguese military superiority, agricultural technology in the form of steel tools resulted in the transformation of indigenous practices, with stone axes and digging sticks being substituted by steel axes, machetes, hoes and brush hooks. Where previously large trees were ringed with stone axes and left to dry slowly, and saplings were bludgeoned over (Daniel, 1776), steel tools greatly reduced the labor expended in agricultural clearing, with the result that what is considered today as "slash-and-burn" agriculture probably is quite different from what was practiced in pre-European Amazonia. Pre-Columbian agriculture most likely had greater affinity with slash-mulch systems, as fires used to prepare fields would have been much less intense, and ringed trees would slowly drop a layer of leaves over the field. The initial difficulty in opening fields out of forest probably led to a longer use of cleared areas, through complex polycultures and crop sequences, including trees. A more extended use of fields may have been possible due to the input of organic matter from the slowly dying original vegetation.

Catholic missions were in part responsible for the introduction of new technologies and agricultural practices. The Jesuit missions in particular were generally well-managed enterprises that exported a part of their production. Persuading natives to leave their villages and move to these missions involved a number of strategies, besides force, including convincing them that epidemics of introduced European diseases were caused by the insalubrities of their village sites. In some cases, life in a mission was the only alternative to being attacked and enslaved by colonists.

Life in the missions brought together individuals of separate tribes, with different languages and cultures, for the compulsory adoption of the body of beliefs and customs of the colonizer. The cultural result was a patchwork of beliefs, the syncretism of shamanism with a vague observance of Catholic saints and holidays, the base for a "folk Catholicism," incorporating various native practices and beliefs and the colonial influences of the Portuguese, as well as African slaves (Ribeiro, 1997; Maués, 2001). Some of these beliefs are associated with a variety of magical/medicinal plants (e.g., pião roxo, *Jatropha gossypiifolia*) often cultivated in modern homegardens, and which along with ornamentals, are often seen even in diminutive front yards in cities such as Manaus.

A characteristic of European colonization of Amazonia was the introduction of a number of exotic fruit trees. In 1662, Mauricio Heriarte (in Huber, 1904) described Belém as cheerful and full of fruit trees such as oranges, limes (*Citrus aurantifolia*), sweet limes (*Citrus limetta*) and biribás (*Rollinia mucosa*). The introduction of mango (*Mangifera indica*) to Belém in 1780 is credited to the Genovese architect Antonio Landi, who brought seeds from Bahia, the capital of Brazil until 1763. The Portuguese Crown officially sponsored a number of plant introductions from its eastern colonies of Goa (India) and Macau (China) and the establishment of a botanical garden in Belém (Dean, 1995). In 1808, in retaliation for the invasion of Portugal by France, the Portuguese invaded French Guiana and were able to take advantage of the collection of useful plants cultivated in Cayenne's botanical garden. By the time Cayenne was returned to the French in 1818, a number of tropical species had been sent to Belém, along with unspecified European fruit trees that had been acclimated in Cayenne (Holanda, 1965). Coffee was another introduced tree crop that soon proved lucrative for Brazil by the 1800s. Coffee germplasm was introduced to Belém in 1727 by Sargeant-Major Francisco de Mello Palheta, who transported five coffee seedlings and a handful of seeds from Cayenne. The first sample of coffee grown in Pará was sent to Lisbon in 1732, and two years later in 1734, 45 tons were shipped (Homma, 2003).

By the mid-19th century, exotic fruit trees had been fully incorporated into homegardens along the Amazon. Traveling on the Amazon between Óbidos and Manaus in 1849, the British naturalist Henry Walter Bates described homegardens with banana, papaya (*Carica papaya*), mango, orange, lemon (*Citrus* sp.), guava (*Psidium guajava*), avocado (*Persea americana*), abiu (*Pouteria caimito*), genipap (*Genipa americana*), and biribá, as well as coffee shrubs growing under the shade of the fruit trees (Bates, 1863). Ten years later, French traveler Robert Avé-Lallemant recorded a variety of fruit trees growing near houses on the outskirts of Belém: banana, mango, jackfruit (*Artocarpus heterophyllus*), various Annonaceae, orange

trees, coffee, as well as the giant granadilla or maracujá-açu (*Passiflora quadrangularis*). Surrounding the dwellings of Indians near Cametá, Pará, he found native calabash trees (*Crescentia cujete*) and orange trees competing with mango, and the native açaí (*Euterpe oleracea*) and bacaba (*Oenocarpus bacaba*) palms. The presence of various Annonaceae, the bacuri (*Platonia insignis*) and brazilnut (*Bertholletia excelsa*) trees was also noted. Besides the homegarden, other tree species were cultivated as commercial crops, and income sources for these households came from "extensive stands of cacao" and rubber trees. Continuing up the Amazon to Santarém, he found many cacao and orange groves, as well as concentrations of the native tucumã palm (*Astrocaryum vulgare*), highly appreciated for the edible mesocarp of its fruits (Avé-Lallemant, 1859).

In Peru, coffee, mango and avocado germplasm entered the Amazon Basin from both the east and west. Avocado entered Peru and the Peruvian Amazon well before the arrival of the Spaniards, while coffee and mango cultivars in Amazonia were introduced from either direction. Accounts from early explorers suggest most mango germplasm came from coastal Peru. Besides Asian species, the Spaniards also brought plant species from and via Central America and the Caribbean. Thus, we might expect common crops of the colonial era such as bananas, beans (*Phaseolus vulgaris*), citrus, or sugarcane in the Peruvian Amazon to have diverse origins even soon after their introduction to the region. Explorers such as Eduard Poeppig, who studied the upper Amazon in 1829-31, have found that much of the cassava germplasm in Peru came from downriver in Brazil, while banana germplasm as far downriver as Manaus, Brazil, often came from Peru (Poeppig, 2003).

By no means, however, was the cultivation of trees limited to the traditional pattern of homegardens or commodity crops. Some homegarden species were creatively adapted to other uses, as is the case of the yellow mombin (*Spondias mombin*; Smith, 1999) and the calabash tree for live fences in the *várzea* (floodplain) region. Similarly, other species that were not previously cultivated, such as the munguba (*Pseudobombax munguba*), a common tree of the *várzea*, were enrolled to mark property boundaries on floodplain ranches. Species such as the rubber tree were added as economic elements, as a small rubber boom during World War II led to a renewed interest in this crop, and a low level of tapping continued even after the war.

2.4. The caboclo *and* ribereño *in the regional economy*

While colonization caused the demise and/or slow absorption of the indigenous tribal populations, a new hybrid society of non-tribal peoples was on the rise. The *caboclos* of Brazilian Amazonia are of mixed descent, as well as the remnants of the acculturated tribes. Similarly, the *ribereños* in Peru are of mixed European and Amerindian descent. Despite the persistent use of the term in the literature, these rural inhabitants do not actually call themselves "ribereños." They most often refer to themselves in occupational or class terms such as *pescador* (fisherman) or *chacarero*, as *chacra* is the common name for the plots of land they farm (Penn, 2004). Researchers point to the Cocama-Cocamilla tribal origins of *ribereños* in Peru, but *ribereños* have diverse origins, and it is not advisable to generalize about

their ethnicity. The origin and ethnicity of the Cocama-Cocamilla themselves is still poorly understood (Cabral, 1995).

Although very similar to the original native populations in terms of their ecological adaptations and subsistence practices, the *caboclos* in Brazil were very different socially (Ribeiro, 1997). Historically, they have been embedded in an agricultural and extractive economy, trading raw materials and products collected from the forests and rivers, or grown in their fields, for the manufactured items and tools necessary for their subsistence. For the most part, there was an ample supply of land for the harvest of extractive products and for fields, under communal tenure or belonging to absentee owners and defunct rubber estates. In recent decades, however, this situation has changed as development of a different form has reached Amazonia, with the construction of roads shifting the economic axes away from rivers and floodplains to the *terra firme*, where human occupation has been characterized by a moving frontier of logging, ranching, and agricultural colonization, that leaves in its wake a landscape dominated by pasture and to a lesser extent swidden agriculture. As rights to land have become more disputed, homegardens have taken on another socioeconomic function, with the presence of cultivated trees used as proof of land tenure and property rights.

3. HOMEGARDENS IN PRESENT-DAY *CABOCLO* AND *RIBEREÑO* SOCIETIES

Homegardens in Amazonia are variously referred to in folk denomination as "huertos" or "jardíns" (in Peru), and "quintais" (yards) or "sítios" (homesteads) in Brazil, as well as "pomares caseiros" (home orchards) or "miscelânea" by researchers. They combine native species with fruit trees introduced from other parts of the globe during European colonization, as well as more recent introductions. In a survey of 33 upland homegardens across the Brazilian Amazon, Smith (1996) found a total of 77 tree species, of which 46% are indigenous to Amazonia, and 27% are from the Old World. In a study of 51 homegardens in Peru (Lamont et al., 1999) at least 30 of the 161 species found were exotics, including nine tree species. In the three villages (two of the Yagua tribe and one *ribereño*), the two most common species in all 51 gardens were of Asian origin (i.e., mango and banana).

The importance of homegardens is chiefly the domestic supply of fruits, condiments, medicines, craft materials, and shade. Near urban centers, however, they may become part of both subsistence and income-earning strategies through the production of marketable fruits. How farmers manage the composition of their homegardens in order to influence production and income generation has been little studied, but it appears that there is a ubiquitous stock of species valued for domestic consumption, while others are cultivated specifically as income-earners. Homegardens near Iquitos, Peru, may cultivate native palms for use in the handicraft business (Lamont et al., 1999), or exotic species such as taperibá (*Spondias dulcis*) for their prized fruits. In the Colombian Amazon, lulo (*Solanum sessiliflorum*) is common in homegardens to supply the markets of Leticia, while the market for fruit from the ocoró tree (*Rheedia* spp.) makes it popular in homegardens near Santa Cruz, Bolivia (J. Penn, pers. obs.).

Amazonian homegardens are very diverse in terms of size and number of species, both on a local level, with properties in the same community exhibiting very different assemblages, as well as on a regional level. While some of these differences can be explained, it becomes clear that there is no such thing as a "typical" homegarden, only trends or patterns. The 21 homegardens studied by Padoch and de Jong (1991) in the community of Santa Rosa, 150 km upstream from Iquitos, generally covered between 300 to 700 m^2, the size of a usual house lot in that community. However, the range in size was from 67 to 7322 m^2. Outlying houses had larger gardens, but this was not always the case. A typical pattern observed in many parts of Amazonia is for houses to be located in the central area of the community, where school, church, meeting hall, soccer field, and television are normally found. These hamlets can be part of planned "agrovilas" of colonization projects, or spontaneously formed communities (often based on kin ties) that group together in order to be attended by municipal services such as schools, health posts, or power generators. In these cases agricultural fields are located at a distance, and some sort of homegarden may be found surrounding the shelter used for processing the cassava crop.

Homegardens in Amazonia also must be studied in the context of how dynamism and change affect the economic, social, and cultural aspects of *caboclo* and *ribereño* societies. A community of 60 households near Iquitos, Peru, whose homegardens were studied by Coomes and Burt (1997), for example, was originally founded as an agricultural estate for the production of sugarcane, rum, and fuelwood, and subsequently was divided up among the former workers in 1971 as an act of agrarian reform. In the community studied by Padoch and de Jong (1991), also near Iquitos, life histories of the adults were found to typically include several long economic migrations and many changes of residence. Lamont et al. (1999) found that the intermarriage of *ribereños* within families of the Yagua tribe was associated with declining use of homegardens in Peru, indicating that researchers need to examine the resilience of these agricultural systems to social and cultural change.

Further study is needed to determine the extent to which differences in homegarden size and diversity are random, a product of local processes of sociocultural development and germplasm accession, or whether they reflect changes in management choice with regard to cash and energy flows and the perceived functions of the homegardens. In some cases, traditional homegardens may be eliminated to make place for more profitable plantations, if agricultural land (space) increases in value, as has been observed in the region near Manaus. If the farmer has the means to invest in a profitable crop, the homegarden can be eliminated to plant papaya (*Carica papaya*) or passionfruit (*Passiflora edulis*), or if still closer to Manaus, to plant horticultural crops (e.g., okra, *Abelmoschus esculentus*). This happens especially on better soils, such as anthropogenic black earths or the *várzea alta*, the higher part of the floodplain or natural levee that accompanies the Solimões and Amazonas rivers (J. van Leeuwen, pers. obs.). Penn (2004; 2006) found that homegardens in Peru were being planted with camu camu trees (*Myrciaria dubia*) by *ribereños* anxious to participate in a regional development program that promoted the cultivation of this species, extremely rich in vitamin C.

A category of Amazonian homegardens originating from rubber-cacao plantations, in which an upper stratum of rubber tree canopies is combined with a lower stratum of cacao, frequently is found on the *várzea alta* of the rivers Solimões, Amazonas, and Madeira. The cacao and rubber trees of this two-layer system are always quite old (J. van Leeuwen, pers. obs.). On the Ilha de Careiro, cacao and rubber were planted at the beginning of the twentieth century when production of these two commodities was much more profitable, but planting no longer occurs (Bahri, 1993). On the Ilha de Careiro and elsewhere many cases can be seen of the gradual substitution of cacao and rubber by other fruit trees, with the result that the plantation develops into a multispecies homegarden (Bahri, 1992; 1993). These examples indicate that homegardens can have a long history, in the sense that present day species composition does not necessarily closely reflect current economic scenarios. This is the case in Central Amazonia, where *várzea* homegardens may contain rubber trees that have not been tapped for many years. Although the presence of species that presently have little economic contribution may simply result from low levels of management, and not a conscious effort of conservation, their maintenance may also be part of risk-avoidance strategies. Poor farmers will generally refuse to cut a tree if it is thought that it might be useful at some moment in the future (J. van Leeuwen, pers. obs., based on work with small farmers in Mozambique and the Amazon).

Differing time horizons and expectations of farmers with regard to local market demands, land tenure and property size all can influence the configuration of homegardens and other agroforestry systems. Access to the markets of larger urban centers represents an important economic factor that comes into play. Studies by Rosa et al. (1998a; 1998b) near the state capitals Macapá (Amapá), and Belém (Pará), Brazil, for example, found that small livestock can have considerable economic importance as components of the homegarden system. In properties averaging 90 ha near Macapá, although more than 50% of the chickens, ducks, and pigs raised was consumed by the household, weekly revenue from livestock averaged R$ 35, a value greater than that obtained from the sale of fruits such as açaí, bananas, mangos, limes, and cupuaçu (*Theobroma grandiflorum*), which averaged R$ 20/week [the real (R$) was approximately equal to the US dollar at that time and is now exchanged at R$ 2.3 per US$]. Nevertheless, a good portion of the feed for these animals was said to come from homegarden fruits. In a survey of 20 households near Belém, where property size averaged 1.7 ha, it was found that families consumed 69% of the fruits, 100% of the medicinals, 85% of the vegetables, and 85% of the livestock, with the remainder being sold (Rosa et al., 1998c). Conversely, livestock can destroy homegardens, and make it impossible to maintain or restart a homegarden. The introduction of water buffalo near Iquitos has greatly reduced the number of homegardens where these animals are present (J. Penn, pers. obs.).

4. HOMEGARDEN MANAGEMENT IN AMAZONIA

According to Lathrap (1977), the maintenance of homegardens and clean yards around the dwellings of indigenous communities creates a domesticated microcosm out of the surrounding wild forest, otherwise the abode of spirits and other dangers.

In Waimiri Atroari villages in Central Amazonia, this zone is used by small children, who both forage and play at activities such as shooting lizards with toy bows and arrows (R. Miller, pers. obs.). Although the extent to which Lathrap's cosmological interpretation of the significance of homegardens can be applied to *caboclo* and *ribereño* societies may be limited, the maintenance of a *terreiro*, or *patio* (bare-earth yard) often swept daily, is a ubiquitous feature of rural homes in Amazonia, and serves to reduce hiding places for snakes and insects. The size of this yard is typically about 500 m^2 (20 x 25 m) and may often be larger. The exact limit of the *terreiro*, however, may depend on the time and labor available for weeding. Beyond the *terreiro*, the divide between the homegarden of planted trees and neighboring second growth may not be clearly distinguishable. These fluctuating boundaries between the bare earth yard, the homegarden, and encroaching second growth vegetation are important in permitting the establishment and recruitment of volunteer seedlings of useful trees. Discarded or fallen seeds will germinate in the shelter of leaf litter and undergrowth, and resulting seedlings may be spared by the observant farmer during periodic weeding. This process was noted by Huber (1904), who was probably the first to make specific mention of the ease with which even introduced species of fruit trees in Amazonia become sub-spontaneous, germinating from discarded seeds in the more fertile soil around dwellings. This "spontaneous" aspect of homegardens is in fact an important form of management. Near Iquitos, for example, Padoch and de Jong (1991) found homegardens to be a "combination of trees left from pre-existing fallows or forests, deliberately planted vegetation, spontaneously occurring useful forest plants, species transplanted from the forest, seeds germinating from the forest," resulting in mosaics of different-age vegetation. They also found that 14% of the plants identified as "non-cultivated" were useful and had been selected for in previous weeding operations. This process, also important for outlying fields, fits into what Wiersum (1996) described as the "second stage of domestication," and is suggestive of how trees may have been incorporated into agricultural systems in Amazonia during the past millennia. Some species will simply regenerate more easily than others in these environments. This is a major reason why *Rheedia*, *Genipa*, and *Inga* species are so common in homegardens along the Peruvian Amazon (Penn, 2006).

Areas beyond the yard that are not kept "clean" provide a dumping ground for assorted household and garden wastes, which besides being important as sources of seeds and forage for domestic fowl, can also represent significant nutrient additions. Over millennial time scales in Amazonia, humans have generated patches of higher fertility around their dwellings by concentrating nutrients obtained from surrounding terrestrial and aquatic ecosystems, resulting in anthropogenic "black earths" (Lehmann et al., 2004). Data from a hunting study with the Waimiri Atroari tribe in Central Amazonia (Mazurek, 2001) indicates that an average-size village of 50 people discards approximately 1.5 Mg of bones of game animals every year. Bones represent a significant contribution of calcium and phosphorus, which complement the other nutrient elements found in other forms of household wastes. Although redirecting nutrients can be a conscious practice, such as when farmers place cassava peelings at the foot of selected fruit trees as fertilizer, for the most part, the nutrient peak around dwellings that greatly benefits homegardens is an unconscious

practice. Nevertheless, in the case of Waimiri Atroari villages, the zone of greater fertility is explored for the initial establishment of a belt of fruit trees around the communal dwelling, which then expands outward concentrically (Miller, 1994).

5. IMPORTANCE OF HOMEGARDENS FOR AGROFORESTRY DEVELOPMENT IN AMAZONIA

Throughout history, Amazonian farmers were subjected to exploitation as forces of colonization and trade penetrated the region. They have suffered immensely and have often been dispossessed of their traditional lands, but have shown a remarkable ability to adapt to new environments and socioeconomic scenarios. During this period, their homegardens have changed in many ways. Asian species soon became common in homegardens after the Conquests, and are an increasingly common part of these cultural landscapes. Among the various configurations of agroforestry systems, such as tree/crop combinations in fields, orchards of mixed fruit trees, and enriched fallows, homegardens represent the most widespread agroforestry practice employed by farmers in Amazonia today.

Although farmers near urban centers sell homegarden products (Lamont et al., 1999) as well as livestock (principally fowl) raised in and around homegardens, their overall contribution for domestic consumption is probably more important. In this regard, homegardens represent a robust and time-tested technology, employed by the traditional inhabitants of Amazonia, whether indigenous tribes or *caboclos* and *ribereños*, and from the point of view of food security, they may be of great value on agricultural colonization frontiers, where farmers face a difficult struggle to establish themselves and their families.

Originally managed for subsistence according to ethnic practices, homegardens are now increasingly important for farmer experimentation with commercial crops. As the locus of experimentation with new tree species and cultivation techniques, homegardens have the potential to contribute to the development of other agroforestry systems, and may expand into more commercial groves, as discussed by Penn (2004) on the new camu camu industry in Peru, and Yamada and Osaqui (2006) concerning the farmers of Japanese descent in Tomé-açu, Pará, Brazil. The homegarden can function as a "staging area" for testing new species and storing, safeguarding, and multiplying germplasm for transfer to and between fields (Coomes and Ban, 2004). In this manner, the homegarden can be an integral component of the larger agricultural system of the property as well as a key node in the local network of agrobiodiversity, if one considers the exchange of plant genetic resources between households in a community.

The historical study of the course of development of homegardens as a basic unit of interaction between humans and trees holds lessons relevant to the present-day scenario of advancing deforestation, in which agroforestry is ascribed a potential role in developing more sustainable land use. While the technologies or practices involved in expanding agroforestry systems out to fields are not necessarily those employed in homegardens, they entail similar concepts such as tree culture, nutrient cycling, and permanent soil cover, among others, and in this respect, homegardens

could be considered as a conceptual core for agroforestry development. The basic units of information that farmers need to develop new models of agroforestry systems are in essence the knowledge of tree species, as to their behavior and interaction with other species. Homegardens, where trees can more easily be cared for and observed, offer optimal locations for the introduction and evaluation of new species.

Nevertheless, in any given community, members will exhibit different levels of perception and relationship with plants, varying from the "green thumbs" to those whose interest in plants goes little beyond their daily needs. In the past, such plant lovers were most likely responsible for the domestication of useful species, and today, they are the experimenters and innovators who generate new technologies by acute observation and the ability to create heuristic models of the behavior, growth, and interactions of the various components of their agroforestry systems. This is a very personal and human process of plant management, which mixes personality traits and life histories, and cannot simply be replicated or substituted by research agencies! The complexity of this social/agronomic interface may explain why homegardens appear to elude science, as Nair (2001) remarked.

Making the leap from growing fruit trees around houses for domestic consumption to planting trees in fields for production of fruit, timber, and other products, nonetheless, requires dealing with an entirely different set of constraints. The main constraints to further developing homegardens or expanding them out to fields for greater productivity and income generation are the lack of adequate germplasm, risk of accidental fires, survival of seedlings in the dry season and soil fertility (Smith et al., 1995; Smith et al., 1996; Smith et al., 1998; Miller, 2001). There may also be a need to modify the configuration of species and management practices observed in traditional systems to meet increased nutrient exports and labor requirements, as well as market demands. At present, commercial products obtained from early stages of agroforestry systems are mostly fruits, and marketing such products, especially processed pulps, requires facilities most farmers cannot afford to have by themselves, while farmers' associations lack the entrepreneurial and managerial expertise to run such installations. This factor has led many innovative agroforestry projects dependent on pulp processing facilities down the path to failure (Penn, 2004).

Despite the official interest in agroforestry, due to the immensity of the Amazon region, extension services have been unable to meet the growing demands for technical assistance. This scenario implies that if agroforestry is to fulfill its promise of providing an alternative and more sustainable form of land use in Amazonia, extension efforts need to break out of traditional paradigms and the mold of commodity-based systems to interact with farmers on a different level of knowledge. The traditional socio-cultural practices involved in acquiring and testing new germplasm, as seen in homegardens, must be included in rural development projects, and stimulated by creative new approaches, with farmers viewed as partners and experimenters in the development and domestication of new generations of tree crops. In this partnership, a major role for extension should be to help provide the necessary germplasm and information.

Surrogate homegardens, based at rural schools, where interesting germplasm can be tested and multiplied for access by frontier farmers, while at the same time improving nutrition for their children, are one suggestion to increase the spread and efficiency of extension services. With homegardens as a conceptual core, this form of agroforestry extension should be accompanied by other initiatives and small-scale experiments to improve the productivity of subsistence crops, through the use of green manures, polycultures, and management of organic matter, among other practices. Although this proposal appears to be simple, existing experiences in a similar vein must be identified and studied to know if it can work and how to make it work.

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