WORKING PAPER

Local uses of tree species and contribution of mixed tree gardens to livelihoods in Saleman

Village near Manusela National Park, Seram Island, Maluku (Indonesia)

Ariane Cosiaux

CIFOR

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Cover photo by Ariane Cosiaux
Fruit of a nutmeg tree

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Contents

List of tables and figures

Tables

Figures

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1. Introduction

1.1 General context

1.1.1 Deforestation and forest degradation in Indonesia

Tropical ecosystems are exceptionally rich in biodiversity, containing most terrestrial biodiversity. However, rapid and extensive forest degradation, which causes modifications of ecosystems and fragmentation of habitats, is leading to an alarming loss of biodiversity (Laurence 1999). Most of the 25 "biodiversity hotspots", as defined by Myers et al. (2000), are in the tropics and characterized by high levels of endemism and habitat loss. Two of these are partly in Indonesia: the Sundaland (western Indonesia) and the Wallacea (eastern Indonesia). Environmental degradation in Indonesia has been severe during recent decades (Sodhi et al. 2004). From 1990 to 2005, Indonesia lost 21.32 million ha of forest (17.56% of its forest cover); however, the mean rate of deforestation in Indonesia for the period 1990–2000 (1.78 million ha/year) was three times that for 2000–2005 (0.58 million ha/year) (Hansen et al. 2009). Yet despite this decrease in deforestation, forest loss in Indonesia remains high, with more than 500,000 ha lost each year during 2005–2010 (FAO 2010). The main direct causes of these high rates of deforestation are: conversion of forest to agricultural lands, commercial logging, fire and mining (Sodhi et al. 2004).

1.1.2 Importance of human-modified landscapes

Given this persistently high forest loss, a challenge for conservationists is the creation of new protected areas (Sodhi et al. 2004). However, the effectiveness of protected areas in Indonesia (totaling 24 Mha) varies widely (Curran et al. 2004) and some areas may trigger disputes with local populations (Aumeeruddy-Thomas 2003; Hariyadi and Ticktin 2012), whom governments in tropical countries tend to blame for forest degradation. In many cases, when protected areas are created, local populations are not allowed to carry on natural resource extraction or agricultural activities, and this restriction leads to conflicts with local authorities. Moreover, in tropical regions, 70% of the land is pastureland, agricultural land or a mixture of managed landscapes (Perfecto and Vandermeer 2008) and the remnant forests cannot all be put under protection status. Indeed, the challenge is finding approaches that can slow the decrease in forest cover, ensure stable livelihoods for rural communities and conserve biodiversity outside protected areas (Bhagwat et al. 2008). In meeting this challenge, complex agroforestry systems can offer solutions to forest degradation, insecurity of rural livelihoods and the loss of biodiversity in the tropics (Michon and de Foresta 1995; Swallow et al. 2006; Harvey et al. 2008; Perfecto and Vandermeer 2008). This kind of land use is common in rural Indonesian landscapes.

1.2 The CoLUPSIA project

1.2.1 Partners

In this context of forest degradation and conversion to other land uses, Agricultural Research for Development (CIRAD) and its partner, the Center for International Forestry Research (CIFOR) are conducting a four-year project called Collaborative Land Use Planning and Sustainable Institutional Arrangements for Strengthening Land Tenure, Forest and Community Rights in Indonesia (CoLUPSIA). The project is financed by the European Commission. CIRAD is leading the project in partnership with several nongovernmental organizations (NGOs) and local universities in Indonesia. The project works in two regions of Indonesia: Kalimantan and Maluku.

1.2.2 Study site in Maluku

In Maluku, the pilot site is on the island of Seram. Seram is part of the Wallacea biogeographic region and harbors a large diversity of vegetation types, from coastal mangrove to tropical alpine vegetation (Edwards 1993; Monk et al. 1997). In the central part of the island lies Manusela National Park, a conservation area created in 1997. The national park covers an area of 189,000 ha, or about 10% of the total island area. Most of the island is under forest, despite commercial logging activities in the 1980s and some estate plantations. Historically, the Seramese engaged in subsistence activities such as hunting–gathering and swidden agriculture or more intensive forms of permanent agriculture on the coast (Ellen 1997). As in Papua and all the Moluccas, a common characteristic of the Seramese is their dependence on sago palms (*Metroxylon sagu*), which provide their staple food. The Seramese extract sago starch both from where the palms grow in swamp forests and from where they cultivate them in gardens closer to settlements. This practice considerably reduces the need to clear forests, as the Seramese do not need to grow highland rice (Ellen 1993, 1999; Sasaoka and Laumonier 2011). In addition, cultivation of "spice" trees such as nutmeg (*Myristica fragrans*) and clove (*Syzygium aromaticum*) has long been part of Moluccan history because of European demand for spices which began in the sixteenth century (Ellen 1997). Current agricultural practices in Seram include shifting and permanent cultivation. Here, "shifting cultivation" encompasses swidden cultivation and slash-and-burn cultivation. Both practices start by slashing and burning a patch of forest. Swidden cultivation consists of farming a dry field for a short period before leaving it fallow for a long period, as part of a rotational system. People usually plant yams (*Dioscorea* spp.), taro (*Colocasia* spp., *Alocasia* spp.) or introduced species such as cassava (*Manihot esculenta*) and sweet potato (*Ipomea batatas*). Pioneer farmers practice slash-and-burn cultivation; they open new fields every year without a rotational system, clearing primary forest so they can plant cash crops. Permanent cultivation on Seram is described as complex agroforestry systems, including home gardens and mixed tree gardens (Monk et al. 1997).

1.2.3 Challenges

For collaborative land-use planning, it is important to identify and characterize the different land uses and understand their importance for local communities. In particular, it is necessary to consider local communities' perceptions of the forested landscape and natural resources, as this enables better understanding of local priorities, local challenges for rural livelihoods, forest management and biodiversity conservation.

1.3 The present study within the CoLUPSIA project

1.3.1 Complex agroforestry systems in Indonesia

Definitions and examples

Complex agroforestry systems are tree-crop-based systems with a forest-like structure (Michon and de Foresta 1995, 1996; Torquebiau 2007). Such systems have a high number of components (e.g. trees, lianas, herbaceous plants) and present a multistoried structure similar to those observed in primary or secondary forests (Michon and de Foresta 1995, 1996). In Indonesia, one type of complex agroforestry system is the home garden, called *pekarangan* in Java (Wiersum 1982; Christanty et al. 1986). Home gardens are fenced-in gardens surrounding individual houses, in which several fruit and other trees are planted among vegetables, herbs and annual crops (Kumar and Nair 2004). They are generally intensively tended. However, most complex agroforestry systems are smallholder mixed tree plantations or "agroforests" on lands outside the village and are less intensively managed than home gardens. These systems have high species diversity and tree density and a complex vertical structure. In the literature, they are also referred to as "mixed tree gardens" (Michon et al. 1986) or sometimes "forest gardens" (Wiersum 1982; Marjokorpi and Ruokolainen 2003; Wiersum 2004; Belcher et al. 2005). The term "agroforest" tends to imply the existence of a large block of "forest" in a mosaic of similar agroforestry plots. In this case, the term "forest garden" serves as a synonym for agroforest, but it often corresponds to tree-based systems with a higher proportion of wild trees (Wiersum 1997a, 1997b, 2004).

An example is *parak*, multistoried agroforestry gardens in West Sumatra that are characterized by a complex association of fruit trees such as durian (*Durio zibethinus*), species for commercial purposes (*Myristica fragrans*, *Cinnamomum burmanii*) and other useful trees (Michon et al. 1986). In southeast Sumatra, the "jungle rubber" is another type of complex agroforestry system with high species diversity (268 plant species in a 1000 m^2 plot) and a structure similar to secondary forest (Gouyon et al. 1993). In West Java, bamboo-tree gardens with high species diversity have been studied by Okubo et al. (2010). Michon and de Foresta (1995) reported that villages in the island of Ambon were surrounded by agroforests that combined nutmeg and clove with fruit trees and forest nut trees. Saparua Island has examples of complex agroforestry systems, referred to as *dusun* by Kaya et al. (2002). The major components of these agroforestry systems are clove, nutmeg and coconut palms (*Cocos nucifera*) with a cortege of other tree species. In the north of Seram (Masihulan Village), complex agroforestry systems, including durian, coffee and cocoa (*Theobroma cacao*) gardens were studied by Vallet (2011).

Local management

These tree-based systems are "reconstructed forests" made by humans. The first step in establishing a new agroforestry plot is to totally remove a patch of primary or secondary forest (Gouyon et al. 1993; de Foresta and Michon 1996; Michon and de Foresta 1997). Sometimes, wild trees may be maintained in the plot for shade or timber. These mixed tree gardens are generally established after a phase of slash-and-burn agriculture carried out to grow food crops and are closely associated with shifting cultivation (de Foresta and Michon 1996; Michon and de Foresta 1997; Kaya et al. 2002). Farmers manage their agroforestry systems with a medium level of input (clearing, cutting and planting) which they complement with the use of natural processes for soil fertility, tree regeneration and weed control (Michon et al. 1986; Belcher et al. 2005).

Contribution to rural livelihoods

In most cases, rural households' primary purpose in managing a mixed tree garden is to earn some cash income. In all gardens, a commercially valuable main tree crop is planted as the farmer's main or only source of cash income (de Foresta and Michon 1996; Belcher et al. 2005). In the mixed tree gardens of West Sumatra, cinnamon (*Cinnamomum burmani*), nutmeg and coffee are planted for commercial purposes (Michon et al. 1986). In the southeast of Sumatra, "jungle rubber" is a major source of income for producers, and 70% of the rubber exported from Indonesia is produced by smallholders in rubber gardens (Gouyon et al. 1993; Belcher et al. 2005). In bamboo-tree gardens in Java, clove and coffee have the same economic function. In Maluku, local communities grow nutmeg and clove as a source of cash income (Kaya et al. 2002); similarly, in forest gardens in Sulawesi, cocoa, vanilla (*Vanilla planifolia*) and nutmeg are the main cash crops. Moreover, farmers generate additional income by selling fruit or other commercially valuable products (Wiersum 1982; Gouyon et al. 1993; Murniati et al. 2001) in the local market. Finally, tree gardens provide many subsistence products, such as fuelwood, construction materials, fruit, vegetables and medicines. In the bamboo-tree gardens of Sumatra, 8 categories of uses and 42 tree species have been identified, all of which serve farmers' daily needs (Okubo et al. 2010). Also in Sumatra, durian gardens provide timber for construction, fruit and vegetables (Michon et al. 1986). An inventory of the traditional gardens of Central Sulawesi (Brodbeck et al. 2003) found that 43 of a total 95 species had subsistence uses. In the traditional tree farming systems of West Java, known as *dudukuhan*, tree species meet household subsistence needs as a source of food, medicine, timber for construction and fuelwood (Manurang et al. 2004).

Contribution to biodiversity conservation

As multistoried tree-based systems that mimic natural forests and have high species diversity, agroforestry systems can contribute to biodiversity conservation. First, tree gardens can conserve "planned biodiversity", that is, where a farmer deliberately introduces certain annual and perennial crops into an agro-ecosystem (Swallow et al. 2006; Perfecto and Vandermeer 2008) such as indigenous fruit tree species. Second, tree gardens may conserve "unplanned associated biodiversity", which includes all flora and fauna species that exist in, or colonize, the agro-ecosystem (FAO 2010) and is found in complex agroforestry systems. Indeed, many wild spontaneous tree species grow in tree gardens, where farmers maintain and manage them (Michon et al. 1986; Gouyon et al. 1993; Kaya et al. 2002). Moreover, many shrubs, lianas, epiphytes and herbs grow in complex tree-based systems; an example is a rubber jungle in Sumatra where an inventory identified 268 plant species, including 91 tree species, 27 shrub species, 97 lianas species and 28 epiphyte species (Gouyon et al. 1993; Michon and de Foresta 1995). Many of these systems are also considered important for conserving wildlife by providing a diversity of habitats (Swallow et al. 2006; Bhagwat et al. 2008) and facilitating the movement of mammals, birds and butterflies between patches of natural forest. Finally, complex agroforestry systems provide an opportunity for land managers to reduce pressure on protected areas by forming a forested transition zone between protected forests and human-dominated areas (Murniati et al. 2001).

1.3.2 Aim of the study

In this study, we investigate the importance of mixed tree gardens for the Saleman community, a village near Manusela National Park, on Seram Island, Maluku. The study has three main aims: (i) to understand the place that mixed tree gardens occupy in the village territory, (ii) to describe the structure and tree species composition in mixed tree gardens, and (iii) to assess the importance of mixed tree gardens for livelihoods. These latter two aims involve an inventory of the useful plant species and products supplied by these agroforestry systems.

2. Site and methods

2.1 Study area

2.1.1 Seram and Central Maluku Regency

Seram, the second largest island in eastern Indonesia (Figure 1), has an area of 17,429 km², being about 340 km long and 60 km wide. The island of Seram is part of the Australasian continent, but since its emergence about 3 to 5 million years ago, it has never been connected to New Guinea or Australia by a land bridge (Audley-Charles 1993). It is speculated that it was colonized by plants and animals by "island hopping" via different channels. Its floristic and faunistic composition includes species from both Asia and New Guinea–Australia (Edwards 1993) and some endemic species. The island is very mountainous, with the highest peak measuring 3027 m (Gunung Binaya). The island is non-volcanic and is mainly composed of sedimentary rocks including limestone massifs and metamorphic rocks (Payton 1993). The climate of Seram is tropical ever-wet (only 4 months with precipitation ≤100 mm) with temperatures at sea level varying from 25 °C to 30 °C. The climate is less humid in the north coastal area, where the mean annual rainfall is about 2000 mm and there is a drier season from April to September (Lembaga Meteorologi dan Geofisika 1969); the south coast receives more than 3000 mm of rainfall, with a precipitation peak in July.

Central Maluku Regency covers 11,595 km² (275,097 km² including the sea territory) and encompasses several islands in addition to Seram, including Ambon, Haruku, Saparua and Banda (BPS 2009) (Figure 1). It is divided into districts. In 2010, the regency had a total population of 361,698 people, with an average density of 31 persons/km² (BPS 2012). Livelihoods are mainly based on agriculture and fisheries.

Figure 1. Map of Seram Island, Maluku, eastern Indonesia.
Source: CoLUPSIA

2.1.2 Saleman Village

The study was conducted in the village of Saleman (*Negeri Saleman*) (2°57′S, 129°6′E) and its surrounding agroforests and forested landscape over three months. Saleman is located on the north coast of the island, near the northwest edge of Manusela National Park (Figure 2). It is accessible by a road that is in poor condition. The total population in 2010 was 1666 (BPS 2010). By comparison, at the end of the 1980s, the village had a population

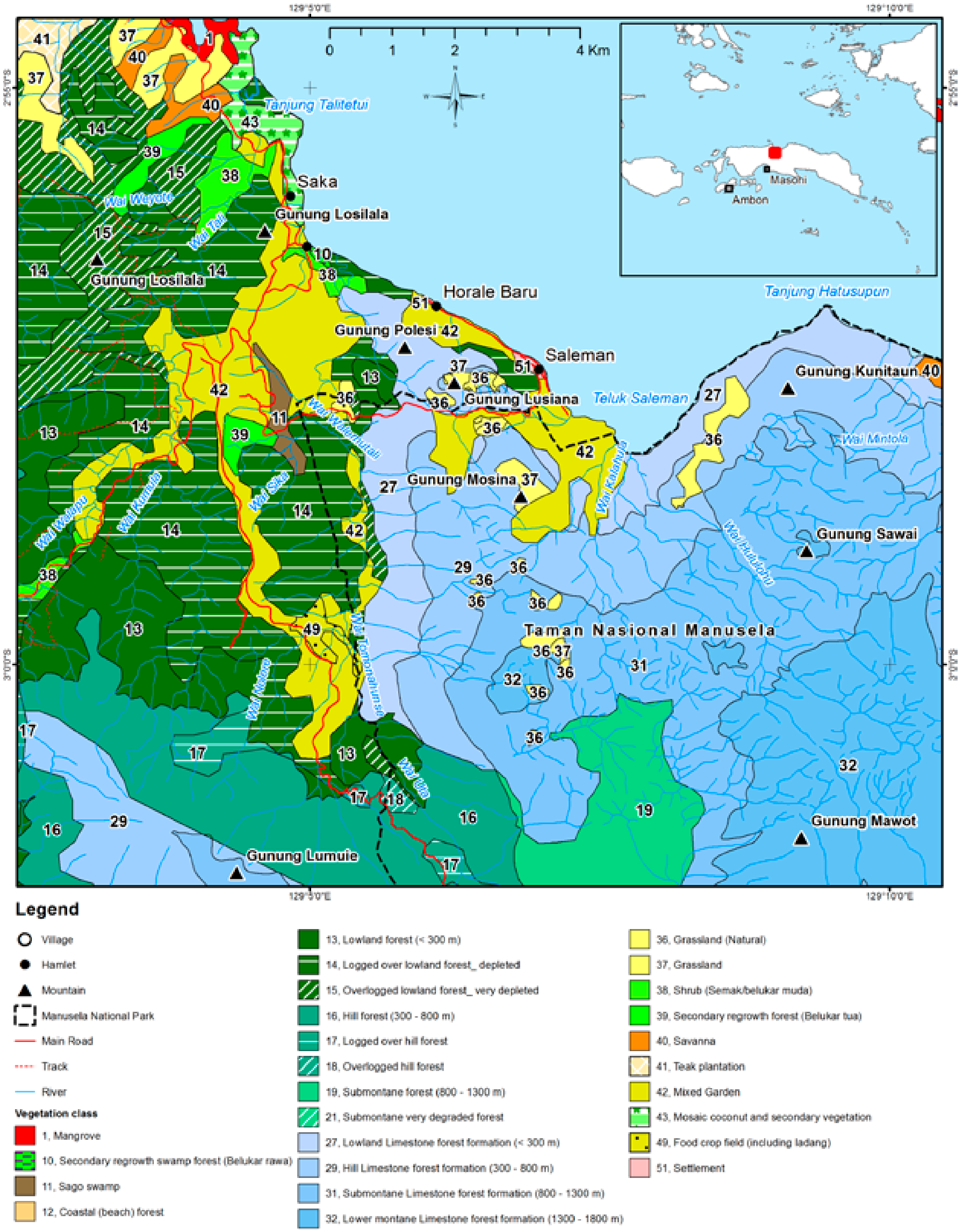

Figure 2. Draft vegetation map of the study site, north coast of Seram Island, Maluku, Indonesia.
Source: CoLUPSIA

of only about 300 (Edwards 1993). The villagers are Muslim, and the two most common economic livelihood activities are agriculture and fisheries. The level of education is low; few people have a tertiary education, but most can read and write. Historically, the people of Saleman belong to the Seramese Nuaulu indigenous group (Ellen 1993). They speak Indonesian, Ambonese and a local Nuaulu language, Bahasa Saleman, which is spoken in only four villages along the north coast (Sawai, Wahai, Hatue and Saleman). This Nuaulu language belongs to the Austronesian phylum (Ellen 2006).

The village is situated on the beach and the surrounding terrain is hilly (Figure 3a, b). The most common vegetation types around the village are lowland and hill forests on limestone, logged-over (depleted) lowland forest and mixed gardens (Figure 2). The mixed gardens are a source of conflict with authorities in neighboring Manusela National Park because 600 ha of gardens are inside the park (personal communication from park authorities, 2012). In addition, in 2006 a conflict arose between Saleman and the neighboring village Horale, as both villages lay claim to the same 10,000 ha of land. In 2008, some of the people of Saleman attacked Horale, burning many houses.

2.2 Participatory mapping and identification of local practices

2.2.1 Participatory mapping

The study began with a mapping exercise that followed the general principles of IFAD (2009). The mapping was conducted with customary (*adat*) leaders to gain an understanding of how they perceive their territory and the position that tree gardens occupy in the landscape. A base map had been previously drawn on transparent paper, depicting neighboring villages, roads, principal rivers and mountain peaks around the village (Bujang 2004). First, informants were asked to name the main rivers, mountains and locations around the village and to draw the boundaries of the village lands, the borders of Manusela National Park and the areas of conflict. Second, I asked them to enumerate and describe the different land uses inside the village territory and sketch them on the map (Martin 1995; Vogl et al. 2004). Once the participants' perceptions of the generic categories of land-use types had been identified, I asked them to describe each land use in detail to identify local subcategories. For example, the generic category "garden" may include subcategories such as "vegetable garden" and "fruit garden" (Vogl et al. 2004). Finally, I asked them about the activities inside each land-use type. This exercise was crucial for identifying the different land-uses around the village, especially the mixed tree gardens, which I intended to study in detail.

2.2.2 Management of mixed tree gardens: Identification of local practices

To identify the local management practices for mixed tree gardens, I conducted 15 structured interviews with farmers. A set of questions had been previously prepared, written in a way to guide the interviews. The first questions covered the attributes of the garden, and then sought information on management practices, from creating a new garden to the usual management practices in an established garden. Other questions addressed harvests, tree diseases and problems (Appendix 1). All interviews were conducted in Indonesian without a translator.

(a) (b)

Figure 3. The village of Saleman, Seram Island, Maluku, eastern Indonesia. The village is on the north coast of Seram. It is on the beach (a) and is surrounded by a hilly forested landscape (b).

2.3 Typology of mixed tree gardens

2.3.1 Sampling design

Sample sites were selected based on the participatory map and discussions with local informants. In total, 22 gardens (approximately 28 ha) were visited, all of which were within 4 km of the village. To study the vegetation characteristics, I marked out a small plot of 20 × 20 m in each garden. As much as possible, plots were selected at similar elevations, on similar slopes and in areas with relatively homogeneous environmental conditions. The mean slope within each type of garden varied between 4° (±6) and 16° (±9). The plot size was chosen based on methods and empirical knowledge generated by the CoLUPSIA project during studies of agroforestry systems in other locations (Comptour 2011; Vallet 2011). These studies found that a 400 m² plot makes it possible to visit several gardens of all types, to ensure relative homogeneity inside each plot (slope, soil etc.), and to strike a balance between covering a large sample of gardens and limiting the work time for each plot. All the gardens studied were established more than 30 years ago. In total, I sampled five plots (0.2 ha) for each type of mixed tree garden.

2.3.2 Recorded variables

In each plot, all trees with a diameter at breast height (dbh) of ≥5 cm were inventoried; their height was estimated, vernacular names recorded and voucher specimens collected. For each type of mixed tree garden, I drew a sketch "profile diagram" of one 400 m² plot, noting the position of trees inside the plot, the height and the crown span. In each garden visited, tree species found outside the plot were inventoried (local name and voucher specimens).

2.3.3 Data analysis

Structure

The overall tree density (total number of individuals with dbh ≥5 cm), the density and the relative density of regenerating trees (5 cm ≤ dbh <10 cm) and only trees with a dbh ≥10 cm were calculated. To analyze diameter distribution, all trees with a dbh ≥5 cm were allocated to diameter classes (5–9.9 cm, 10–19.9 cm, 20–29.9 cm etc.). To analyze height distribution in each type of garden, all trees were allocated to one of four height classes (2–7 m, 7.1–15 m, 15.1–25 m, >25 m). Then, for each type of garden, the number of continuous layers was determined based on field observations and the height distribution. The mean height of the continuous layers and the total basal area, G, were calculated. In this way, density, relative density and total basal area were systemically determined for all mixed tree gardens (25 plots) and for each type of mixed tree garden (5 types).

Floristic composition

The number of families and the species richness (S) were determined at garden scale (based on all tree species inventoried in one garden) and at plot scale (based on the tree species inventoried inside the plots only). The index of Margalef (D_{mg}) was calculated (Magurran 2004) at plot scale. The importance value index (IVI) (Cottam and Curtis 1956) of each species was calculated as the sum of relative density, relative frequency and relative dominance. For relative dominance, we used the basal area. The IVI was used to identify the most important species for each type of garden and for all gardens. With regard to the vertical structure of each type of garden, the most abundant species and the dominant species of each layer were identified based on their relative density and relative dominance, respectively. Then, the Simpson diversity index (1 – D) (Marcon 2011) was calculated to examine the β-diversity of all gardens and of each garden type. We also used the index of Sorensen (Magurran 1988) of plant similarity to determine the β-diversity among garden types. All formulas used to calculate indexes and variables are summarized in Table 1.

2.4 Ethnobotanical knowledge

To determine the role of mixed tree gardens in household livelihoods, ethnobotanical data on how the people of Saleman use plants were collected.

2.4.1 Interviews on local uses of tree species in mixed tree gardens

To identify the local uses of tree species, 15 structured interviews were conducted with the same farmers interviewed on garden management. During each interview, the farmer and I walked through his garden, and he gave me the vernacular name of each tree species in Indonesian and in the local language (Bahasa Saleman). In cases where farmers did not know the vernacular name in the local language, the information was supplied by a key informant, who is fluent in the local language and knows all the vernacular names of plants. Then, for each species inventoried, questions were asked about the local uses, following the procedure recommended by

Table 1. Biodiversity and species richness indexes and other variables calculated for the data analysis.

Parameters and indexes	Formulas	Explanations
Variables and indexes used to analyze the structure and floristic composition of gardens		
Density	N	Number of trees per unit area
Relative density	(Ni/N)*100	Ni = number of individuals of one species
Individual basal area, g	$\pi*(D/2)^2$	D = tree diameter
Total basal area, G	$G = \sum_{i=1}^{N} gi$	N = the number of individuals
Relative frequency	(number of plots containing a taxon/total frequencies of all taxa)*100	
Relative dominance	(basal area of a taxon/total basal area of taxa)*100	
Importance value index (IVI)	(relative density + relative frequency + relative dominance)	
Species richness	S	Number of species
Index of Margalef Dmg	(S – 1) / ln N	This species richness index takes into account the total number of individuals inventoried
Simpson diversity index (1 – D)	D = Σ Ni(Ni-1)/N(N-1)	Probability that two randomly selected individuals will not belong to the same species (range: 0–1)
β-diversity index of Sorensen Cs	2j / (a + b)	j = number of species common to both sites; a = number of species in site A; b = number of species in site B
Index used to compare the content of free lists		
Similarity index	SI = n*s* / (n*m* + n*w* – n*s*) * 100	n*s* = number of species named by both men and women; n*m* = number of species cited by men; n*w* = number of species mentioned by women

Martin (1995) and Vogl et al. (2004) (Appendix 1). For commercial species, I recorded the sales prices and market locations. Through these interviews, I identified the local uses of each tree species and the use categories for mixed tree gardens.

2.4.2 Free listing

Data collection

Free listing is a structured interviewing method used in ethnographic research to elicit systematic data on a "cultural domain" (Gravlee 1998; Quinlan 2005); here, a "cultural domain" refers to an organized set of words, concepts or sentences that comprises a single mental category or semantic domain (Weller and Romney 1988). Free listing consists of asking the respondents to list as many names of X as he or she can, where X is the cover term for a cultural domain (e.g. kind of wood for building). Free listing generates two types of information about a cultural domain: which items belong to it and how items are structured inside the list (Gravlee 1998). For most coherent domains, having 20 to 30 informants is usually sufficient (Weller and Romney 1988). In this study, 27 household heads (15 men and 12 women) were asked to list all the plants they know for a set of 16 uses. The 27 respondents were randomly selected to ensure inhabitants from all parts of the village were included. The uses were those previously identified during interviews with farmers. The free listing exercise served two purposes: to identify which plants villagers associate with each use and to determine the most culturally important plants for each use. All growth forms (not only tree species) and origins (gardens and forest) were included in the free-listing exercise, in order to capture all the plant diversity used by communities. This method makes it possible to collect supplementary data about local uses of species in mixed tree gardens and to identify other important useful species. Indeed, a combination of free listing and structured interviews substantially increases the quality and quantity of data (Brewer 2002).

Data analysis

The two most important results from free listing are the frequency and order with which each item is cited across all respondents (Gravlee 1998; Quinlan

2005). According to cognitive anthropology[1], items mentioned frequently and near the top of the lists are culturally important. Moreover, most lists took on a core–periphery structure: most respondents mentioned a small set of core items and individual respondents mentioned a much larger set of peripheral items (Gravlee 1998). Also of interest are the differences in list length and content, which reveal intra-cultural variations in respondents' knowledge (Quinlan 2005).

First, to identify any quantitative differences between the species mentioned by men and those mentioned by women, the mean lengths of the lists generated by each gender group for each use were compared using Student's t-test. Next, for each use, the core species in terms of frequency were identified. The following analysis focuses only on these core species.

To quantify the qualitative differences between species listed by men and women, a similarity index (%) was calculated for each use (Table 1). Then, the composite salience value of each species for each use was determined separately for men and women. Salience is a statistic accounting for the rank and frequency of each item cited in the list (Smith 1993). First, for each use, the salience of listed species (S) was calculated for each participant in the free listing (Table 2), followed by a composite salience value for each species for each use (Table 3). For each use,

Table 2. An example of how to determine the salience (S) of each item mentioned by a free lister

Illness	Inverted Rank/ Total Listed	Salience (S)
Vomiting	5/5	1
Pressure	4/5	0,8
Sore throat	3/5	0,6
Something "hurts" you	2/5	0,4
Sprains	1/5	0,2

Note: Items mentioned by the free lister here are illnesses. "Vomiting" is the first item that was mentioned and "sprains" is the last one. To determine the salience (S) of each illness mentioned, first rank the items inversely (the final item listed is equal to one) and then divide the ranking by the number of items mentioned.

Source: Quinlan (2005)

Table 3. Example of how to calculate the composite salience value for each illness cited by three free listers.

	Free lister				
Illness	1	2	3	Illness ∑	Composite salience ∑/n (n=3)
Worms		1	1	2.000	0.667
Pressure	0.8	0.571	0.652	1.996	0.665
Buttons		0.865	0.75	1.615	0.538
Vomiting	1	0.428		1.428	0.476
Cold		0.857	0.5	1.357	0.452
Inflammation			0.875	0.875	0.292
Sore throat	0.6		0.25	0.850	0.283
Cough		0.286	0.35	0.636	0.212
Something "hurts" me	0.4			0.400	0.133
Sprains	0.2			0.200	0.067
Asthma		0.143		0.143	0.048
Cuts			0.125	0.125	0.042

The composite salience value of one item is the sum of all salience scores for that item, divided by the number of free listers.
Source : Quinlan (2005)

1 Cognitive anthropology involves studying the content of thought in communities of individuals. For example, cognitive anthropologists seek to discover the pattern of shared knowledge or how collective understandings of the world emerge in social groups.

and for men and women, a bar graph was created, showing the species classified in descending order of composite salience value, thus setting out the highly salient, salient and less salient plant species based on the observation of salience breaks (or salience thresholds) (Quinlan 2005). The free lists were analyzed using the software Anthropac 4.0, which calculates an index of cultural importance (salience value). This analysis was conducted using the vernacular names of species.

2.4.3 Plant voucher specimens

Plant voucher specimens of each tree species inventoried in mixed tree gardens and each species mentioned in the free listing were collected (leaves, fruit and flowers when possible) in five duplicates. The specimens were conserved in newspapers soaked with denatured alcohol (spiritus) before drying, and brought to Bogor Herbarium for identification. It was not possible to collect voucher specimens of 30 species known only by their vernacular names (Appendix 2).

3. Results

3.1 Customary landscape: The *petuanan* of Saleman

3.1.1 Customary governance of landscape management

Saleman was established more than a century ago. The people still apply customary rules on local governance, land management and extraction of forest products. Seven clans (*soa*) are represented in the village (in order of their arrival to the village): Makuituin, Aloatuan, Rumaolat, Ialuhun, Aloahiit, Upuolat and Makatita. Makuituin is the founding clan. A local government (*pemerintah desa*) runs issues affecting everyday life in the village. In addition, a customary government (*pemerintah adat*) oversees customary rules and rituals and the allocation and management of village land. The Makuituin clan heads the customary government, as the *raja tanah*, and the Makatita clan heads the local government as *raja*. The Rumaolat clan serves the role of war leader, *kapitan*. The Makatita clan, the last to arrive, is not a member of the customary government and has no responsibilities or part in decisions regarding the land. The *petuanan desa* (village land territory) is further divided into *lahan soa* (lands of clans) (Figure 4) but the Makatita have no lands. At the time of the first settlers, all the land belonged to the Makuituin, as the founding clan. The land was later distributed among the other clans, except the Rumaolat, who share the same lands as the Makuituin. Although each clan has certain lands, a member of a clan can use the land of another clan (e.g. to make a new garden) with authorization from that clan.

3.1.2 Participatory mapping and folk classification of landscapes

Saleman villagers distinguish four categories of landscapes: *ewang*, *aung*, *aka* and *dusun*.

Ewang is the natural forest left undisturbed by human activities or natural hazards. This forest is far from the village (≥5 km) (Figure 4).

Aung describes a forest that has been disturbed by human activities (e.g. timber extraction) or natural hazards (e.g. fires, landslides). It includes two subcategories: *hutan sudah ditebang*, which refers to forests from which people have taken timber only, and *bekas kebun* or *bekas aka. Bekas kebun* and *bekas aka* correspond to secondary regrowth, which is abandoned gardens regenerating into secondary forest. This commonly happens when Saleman farmers leave their tree gardens if they find a better job outside the village.

Kebun in Indonesian, or *aka* in Saleman, describes those gardens where people plant perennial and/or annual crops. This category includes three subcategories: *kebun kecil* or *aka kiiti, kebun besar* or *aka maina*, and *kebun khusus* or *aka khusus.*

Kebun kecil are small gardens (fenced) beside individual houses where people plant a few trees and mostly annual crops (Figure 5a). Not all houses have a small garden.

Kebun besar are gardens outside the village that are not fenced and in which several tree species are planted (and sometimes a few other species). These mixed tree gardens are located around the village (at a distance ≤5 km) (Figure 4). Saleman villagers distinguish between six types of mixed tree gardens: *kebun pala* (nutmeg garden), *kebun cengkeh* (clove garden), *kebun kelapa* (coconut garden), *kebun coklat* (cocoa garden) (Figure 6), *kebun durian* (durian garden) and *kebun langsat* (*Lansium domesticum* garden).

Kebun khusus refers to special banana gardens, called *kebun pisang* or *aka uri*, located on the roadside.

Finally, *dusun* is a land use inside the forest that consists of extracting and managing a forest product. A *dusun* can cover several hectares and is managed collectively by villagers. The term *dusun* encompasses two subcategories: *dusun damar* and *dusun sagu* (Figure 7), from where villagers collect damar resin (*Agathis dammara*) and sago starch (*Metroxylon sagu*), respectively. The *dusun damar* are quite far from

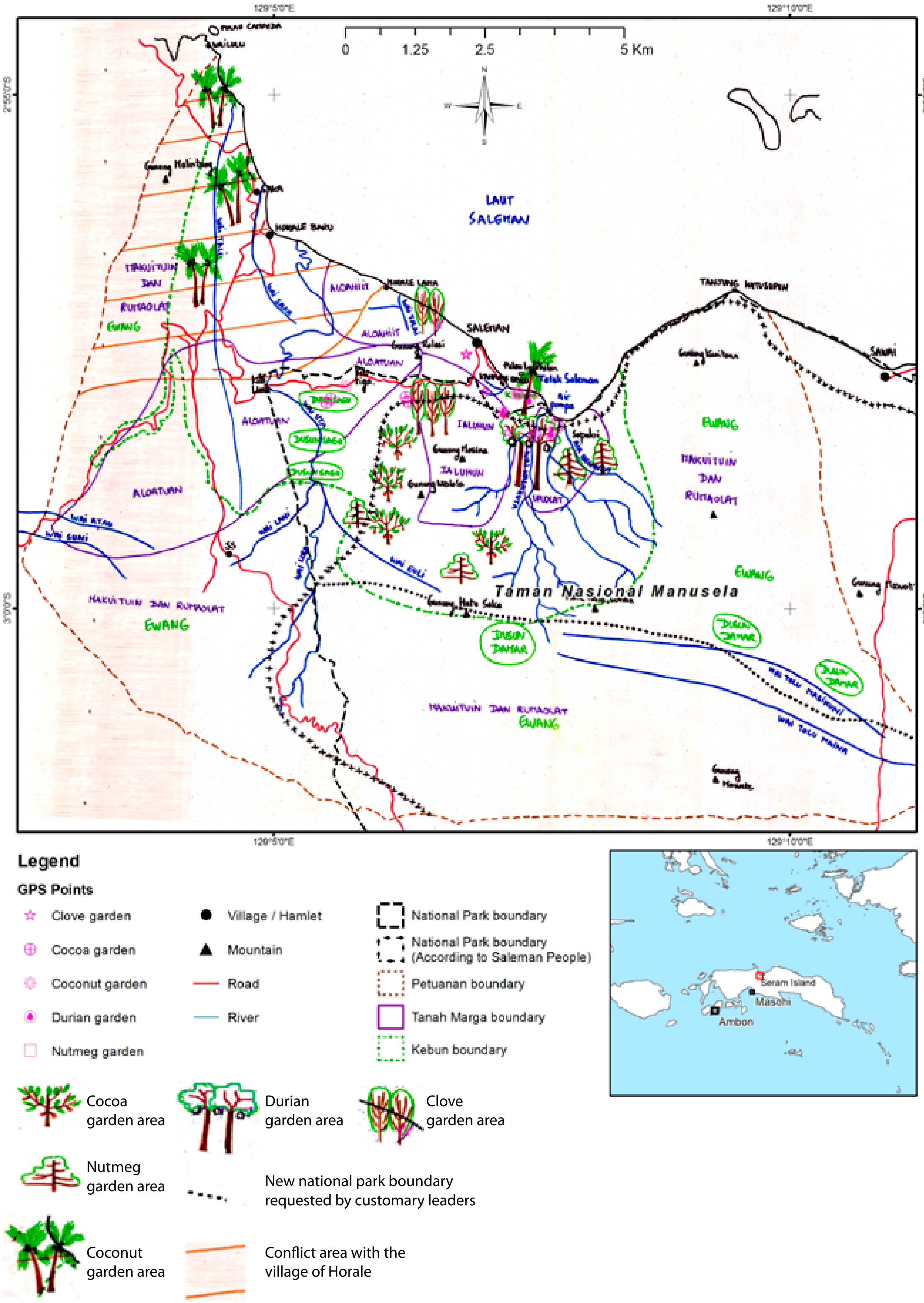

Figure 4. Participatory map of the *petuanan desa* (village land territory) of the village of Saleman created by the customary leaders (Seram Island, Maluku, Indonesia)

Figure 5. (a) A small garden surrounding a house (*kebun kecil* or *aka kiiti*); (b) Coconut seedlings in a small garden.

Figure 6. Cocoa garden (*kebun coklat* or *aka coklat*).

the village, and the *dusun sagu* are located by a river approximately 5 km from the village (Figure 4).

3.1.3 Mixed tree gardens: General characteristics and local management of the *kebun besar*

As seen in Figure 4, and provided that the official park boundary is at the given location (no markers are in the field), many mixed tree gardens are located inside Manusela National Park. The gardens had already been established when the park borders were set. Since the park boundaries were established, six villagers have been arrested by the national park rangers and incarcerated for a few months for establishing new gardens inside the national park. Currently, the customary leaders are asking that the park boundaries be moved. At the same time, Saleman is in the middle of a land dispute with the neighboring village of Horale. People have abandoned their coconut and *langsat* gardens near Horale. *Langsat* gardens were not studied here because they are in the conflict area (Figure 4).

Mixed tree gardens are usually between 0.5 and 1.5 ha. The farmers mark their boundaries by planting trees such as durian or maintaining big wild trees. A mixed tree garden is private land, managed by a family and passed on as inheritance. When a new garden is created, it belongs to the person who cleared the forest and planted the trees. As in many places in traditional rural Indonesia, planting a tree is a way of staking a claim and gaining property rights. Usually (but not always) a new mixed tree garden is made by clearing the vegetation and then burning it. The small gardens surrounding houses are used as nurseries to prepare seedlings (Figure 5b) to be planted inside the new plot. In the past, the establishment of a new garden began with a period of a few months, during which taro (*Colocasia esculenta*) or cassava (*Manihot esculenta*) were planted, and the garden was systematically fenced. Now, however, most farmers have abandoned this practice and plant tree seedlings immediately, within about three months of clearing the forest. The first fruiting period varies between species (Appendix 3). Farmers work in their gardens three days a week and usually have several gardens (1–5 for each farmer).

3.2 Structure and floristic composition of mixed tree gardens

3.2.1 Structure

Density, diameter and basal area

In total, 609 trees were recorded in a hectare of mixed tree garden (25 plots). The cocoa garden had the highest tree density (170 trees/0.2 ha), and the nutmeg garden had the lowest (79 trees/0.2 ha).

The relative density of regenerating trees (5 cm ≤ dbh < 10 cm) is low and varies from 19% for nutmeg gardens to 34% for coconut gardens (Table 4). Durian gardens have the highest total basal area (14 m^2/0.2 ha); this is more than double that of coconut and nutmeg gardens, which both have a total basal area of 6 m^2/0.2 ha. Cocoa and clove gardens both have the lowest total basal areas (4 m^2/0.2 ha).

The mean diameters of trunks (dbh) varied from 15 cm (±10) for cocoa gardens to 25 cm (±20) for nutmeg gardens (Table 4). In cocoa, clove, coconut and durian gardens, most individuals (>50–80%) were in the small diameter classes (5–19.9 cm) (Figure 8). In nutmeg gardens, more than 70%

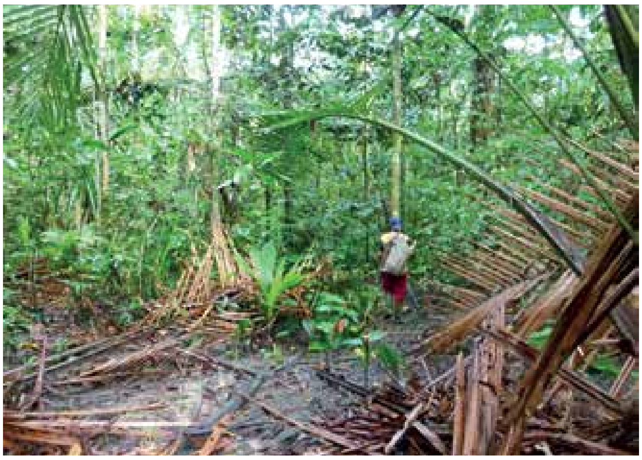

Figure 7. A managed swamp forest (*dusun sagu*).

Table 4. Density, relative density, mean dbh and total basal area of the 1 ha of sampled gardens and the 0.2 ha sampled for each type of mixed tree garden.

Type of garden	Density: all trees	Density: trees <10 cm dbh	Density: trees ≥10 cm dbh	Relative density: trees <10 cm dbh	Relative density trees ≥10 cm dbh	Mean dbh: all trees (cm)	Mean dbh: trees ≥10 cm (cm)	G: all trees (m^2)	G: trees ≥10 cm dbh (m^2)
All (1 ha)	609	181	428	30	70	20 ± 19	25 ± 20	35	34
Cocoa (0.2 ha)	170	52	118	31	69	15 ± 10	25 ± 20	4	4
Coconut (0.2 ha)	130	44	86	34	66	20 ± 15	26 ± 15	6	6
Clove (0.2 ha)	114	34	80	30	70	18 ± 13	22 ± 13	4	4
Durian (0.2 ha)	116	36	80	31	69	24 ± 31	32 ± 34	14	14
Nutmeg (0.2 ha)	79	15	64	19	81	25 ± 20	29 ± 20	6	6

Note: G: Total basal area

of plants were in the three first diameter classes (5–29.9 cm). Durian gardens have more individuals in the bigger size class than other types of garden (>10%), and they contain considerable phytomass. Coconut gardens also have a high proportion (>20%) of individuals in the diameter class 30–39.9 cm.

Vertical structure

The relative distribution of height varies between garden types (Figure 9). In cocoa, clove, coconut and durian gardens, most individuals (>70%) are in the height classes 2–7 m and 7.1–15 m. In nutmeg gardens, most trees are in the height classes 7.1–15 m and 15.1–25 m (>70%).

In cocoa gardens, there is only one continuous layer (2–7 m) dominated by a discontinuous layer between 7 and 15 m (Figure 10). In the continuous layer, *Theobroma cacao* is the most abundant (83%) and dominant species (73% of the total basal area).

In clove gardens, two continuous layers (2–7 m and 7.1–15 m) surrounded by only a few trees >15 m were identified (Figure 11). *Theobroma cacao* mixed with *Syzygium aromaticum* is the most abundant (66%) and dominant (64%) species in the lower layer. *Syzygium aromaticum* also dominates the second layer (44%).

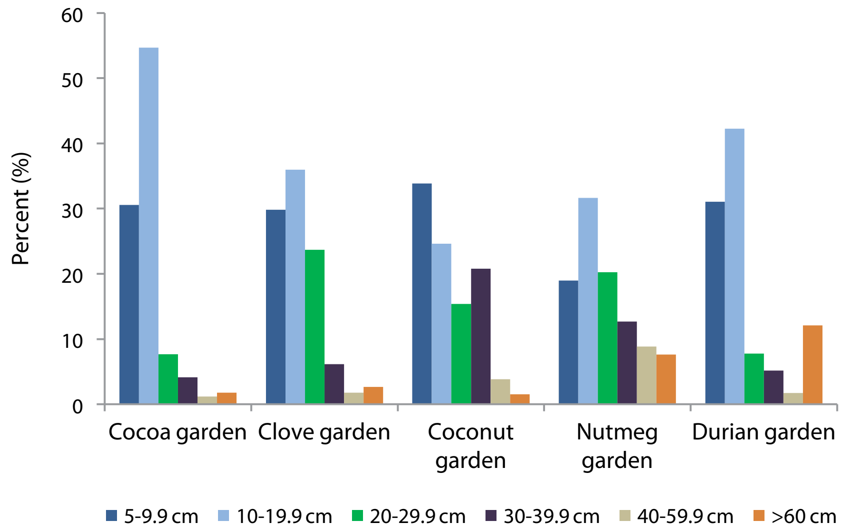

Figure 8. Relative distribution of trees (dbh ≥5 cm) across diameter classes for 0.2 ha of each type of garden.

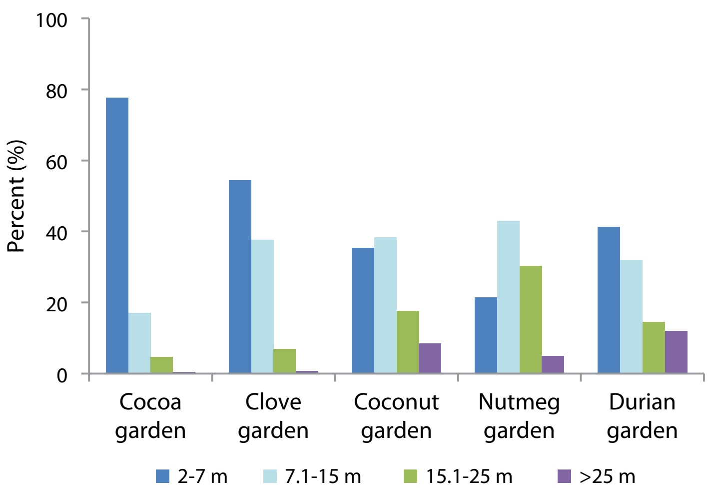

Figure 9. Relative distribution of trees (dbh ≥5 cm) across height classes for 0.2 ha of each type of garden.

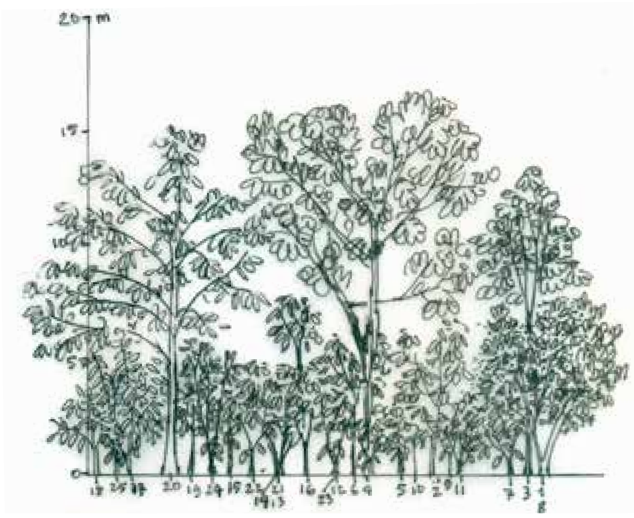

Figure 10. Sketch profile of a 20 × 20 m plot in a cocoa garden, Seram Island, Maluku, Indonesia. All trees with dbh ≥5 cm are depicted.

Species composition

Lower layer

Theobroma cacao (cocoa) *(coklat)*: 2, 4, 5, 7, 8, 9, 11, 12, 13, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25.

Coffea canephora (coffee) *(kopi)*: 10, 14.

Cinnamomum verum (cinnamon) *(kayu manis)*: 1.

Upper layer

Syzygium aromaticum (clove) *(cengkeh)*: 3.

Spondias cytherea (kedongdong): 6.

Syzygium malaccense (jambu makui): 20

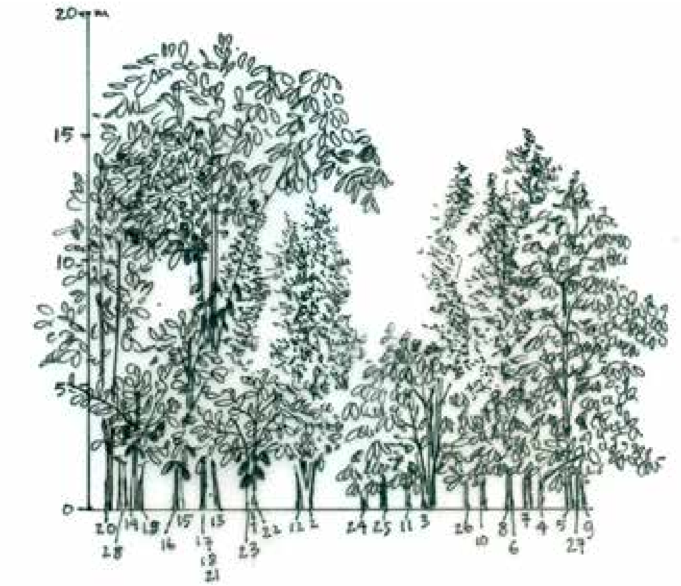

Figure 11. Sketch profile of a 20 × 20 m plot in a clove garden, Seram Island, Maluku, Indonesia. All trees with dbh ≥5 cm are depicted.

Species composition

Lower layer

Theobroma cacao (cocoa) *(coklat)*: 1, 2, 3, 4, 6, 9, 10, 11, 13, 14, 15, 16, 19, 21, 23, 24, 25, 27.

Gliricidia sepium (pohon pelindung): 28.

Upper layer

Syzygium aqueum (jambu air): 5.

Syzygium aromaticum (clove) *(cengkeh)*: 7, 8, 12, 22, 26.

Cordia myxa (kayu semang): 17.

Mallotus ricinoides (kayu kapur): 18.

Lansium domesticum (langsat): 20.

In coconut gardens, there are two lower layers that are more or less continuous (2–7 m and 7.1–15 m) with no clearly dominant species. The most abundant species in the second layer is *Cerbera floribunda* (20%). The upper discontinuous layer (15.1–25 m) is dominated by *Cocos nucifera* (Figure 12).

Nutmeg gardens are characterized by two more or less distinct middle continuous layers (Figure 13), in which *Myristica fragrans* is clearly dominant.

Durian gardens are the most complex, with four layers that are more or less continuous. *Durio zibethinus* exclusively dominates the canopy layer, characterized by a mean height of 37 m (±7 m) (Figure 14). The species is also dominant (76.95%) in the middle layer, where it is mixed with *Syzygium aromaticum* (16.07%). *Theobroma cacao* is dominant in the lower layer (82.39%) and *Syzygium aromaticum* (47.07%) and *Areca catechu* (16.95%) are dominant at between 7 and 15 m. The mean height of each layer is given in Table 5. The dominant and most abundant species of each layer are listed in Appendix 4.

3.2.2 Floristic composition

Within the 22 mixed tree gardens visited (28 ha), 110 tree species belonging to 41 families were inventoried, with 76 species in cocoa gardens (8 ha), 41 species in coconut gardens (5 ha), 40 species in nutmeg gardens (5 ha), 37 species in clove gardens (5 ha) and 32 species in durian gardens (5 ha) (Appendix 5). Moraceae (eight species) and Fabaceae (eight species) were found to be the most diverse tree families, followed by Anacardiaceae (seven species), Euphorbiaceae (six species), Myrtaceae (six species) and Verbenaceae (six species).

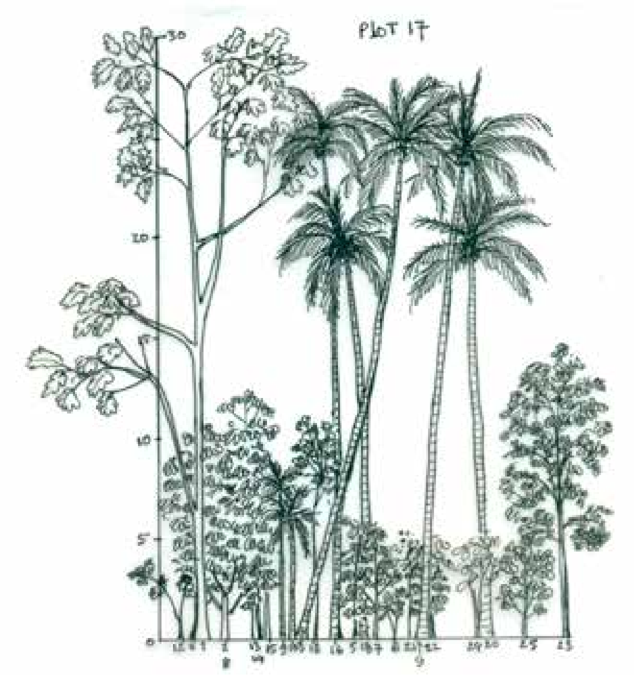

Figure 12. Sketch profile of a 20 × 20 m plot in a coconut garden, Seram Island, Maluku, Indonesia. All trees with dbh ≥5 cm are depicted.

Species composition

Lower layers, 2–15 m

Cynometra cauliflora (namu-namu): 2, 8, 22.
Citrus aurantifolia (lemon cina): 5, 18.
Mangifera indica (mango) *(mangga java)*: 6, 24.
Syzygium malaccense (jambu makui): 7, 23.
Areca catechu (areca palm) *(pinang)*: 9, 10.
Flacourtia rukam (tomi-tomi): 11.
Annona muricata (nangka belanda): 12, 21.
Neuburgia moluccana (jati hutan): 13, 14, 15.
Buchanania arborescens (jambu meteng hutan): 25.

Upper Layer

Artocarpus altilis (breadfruit) *(sukun)*: 1.
Cocos nucifera (coconut palm) *(kelapa)*: 3, 4, 16, 19, 20.

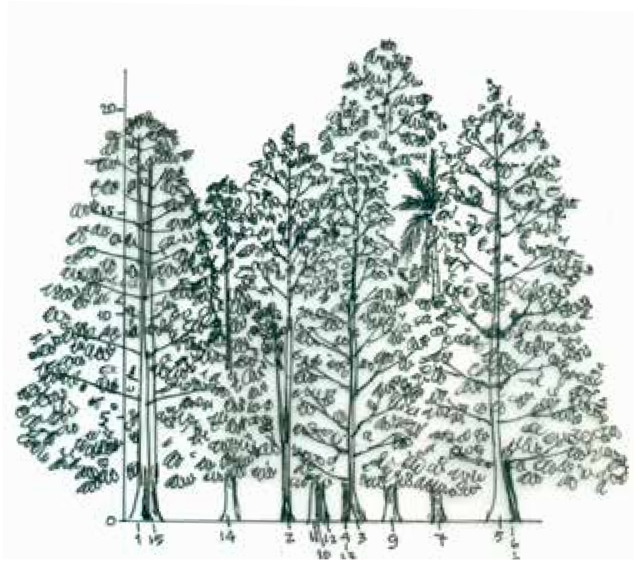

Figure 13. Sketch profile of a 20 × 20 m plot in a nutmeg garden, Seram Island, Maluku, Indonesia. All trees with dbh ≥5 cm are depicted.

Species composition

Myristica fragrans (nutmeg) *(pala)*: 1, 4, 5, 6, 8, 9, 12, 13, 14, 15.
Durio zibethinus (durian): 2, 10.
Lansium domesticum (langsat): 3, 11.
Areca catechu (areca palm) *(pinang)*: 7.

Within the 25 sampled plots (1 ha) belonging to 27 families, a total of 53 species were inventoried, with 32 species in coconut gardens, 27 in cocoa gardens, 17 in clove gardens, 14 in durian gardens and 10 in nutmeg gardens (Table 6). Based on the qualitative index of Sorensen, the highest floristic similarities were found between durian and clove gardens (0.52) and between durian and nutmeg gardens (0.50) (Table 7). At the plot scale, when all garden plots are analyzed together, the Margalef index is 8.11. Among garden types, the richness index of Margalef varies from 2.06 (nutmeg garden) to 6.37 (coconut gardens) (Table 6). For the 25 plots, the Simpson index is 0.87 and it varies between garden types; coconut gardens have the highest index at 0.91, followed by durian gardens (0.84), clove gardens (0.82), nutmeg gardens (0.59) and cocoa gardens (0.54) (Table 6). Even when the relative abundance of each species is taken into account, coconut gardens are the most diverse and cocoa gardens the least. Nutmeg gardens with lower species richness also have a low Simpson index value.

Among the 53 tree species inventoried in the 25 plots, 6 species have a major role, according to their IVI. Not surprisingly *Durio zibethinus*, *Theobroma cacao*, *Myristica fragrans*, *Cocos nucifera*, *Syzygium aromaticum* and *Lansium domesticum* account for 62.94% of the importance value (Figure 15). The three most important species in each type of garden are listed in Table 8. In all, eight species are among the most important. In each garden type, the species that gives its name to the garden has the highest IVI.

Table 5. Mean height (m) of layers in each type of garden.

	Cocoa gardens	Coconut gardens	Clove gardens	Durian gardens	Nutmeg gardens
Lower layer, 2–7 m	5 ± 1	5 ± 1	5 ± 1	5 ± 1	–
Low layer, 7.1–15 m	10 ± 2	11 ± 3	12 ± 2	11 ± 3	11 ± 2
Middle layer, 15.1–25 m	–	23 ± 3	–	18 ± 3	21 ± 3
Upper layer, >25 m	–	–	–	37 ± 7	–

Table 6. Families and species richness and diversity indexes for each type of garden at plot scale and garden scale.

Plot scale						Garden scale		
Plots	Number of families (all trees)	S (all trees)	S (trees ≥10 cm dbh)	Margalef index (all trees)	Simpson's diversity index (all trees)	Type of garden	Number of families	S
All (1 ha)	27	53	45	8.11	0.87	All (28 ha)	41	110
Cocoa garden (0.2 ha)	17	27	22	5.06	0.54	Cocoa (8 ha)	37	81
Coconut garden (0.2 ha)	20	32	23	6.37	0.91	Coconut (5 ha)	24	42
Clove garden (0.2 ha)	13	17	16	3.38	0.82	Clove (5 ha)	23	39
Durian garden (0.2 ha)	11	14	9	2.73	0.84	Durian (5 ha)	23	34
Nutmeg garden (0.2 ha)	7	10	9	2.06	0.59	Nutmeg (5 ha)	21	41

Note: S: species richness

Table 7. β-diversity between the five types of garden based on the qualitative Sorensen index.

Type of garden	Cocoa	Durian	Nutmeg	Coconut	Clove
Cocoa	–	0.44	0.32	0.41	0.36
Durian	–	–	0.50	0.39	0.52
Nutmeg	–	–	–	0.24	0.37
Coconut	–	–	–	–	0.37
Clove	–	–	–	–	–

Table 8. The three most important species in each type of garden according to their Importance Value Index (%).

Cocoa garden		Coconut garden		Clove garden		Durian garden		Nutmeg garden	
Species	IVI (%)	Species	IVI (%)	Species	IVI (%)	Species	IVI (%)	Species	IVI (%)
Theobroma cacao	38.5	*Cocos nucifera*	25.1	*Syzygium aromaticum*	19.6	*Durio zibethinus*	42.3	*Myristica fragrans*	42.9
Durio zibethinus	7.2	*Cerbera floribunda*	6.6	*Lansium domesticum*	18.0	*Theobroma cacao*	13.9	*Durio zibethinus*	16.6
Artocarpus heterophylla	6.1	*Kleinhovia hospita*	6.4	*Theobroma cacao*	16.8	*Syzygium aromaticum*	10.8	*Lansium domesticum*	11.5
Sum	**51.8**		**38.1**		**54.4**		**66.9**		**71.0**

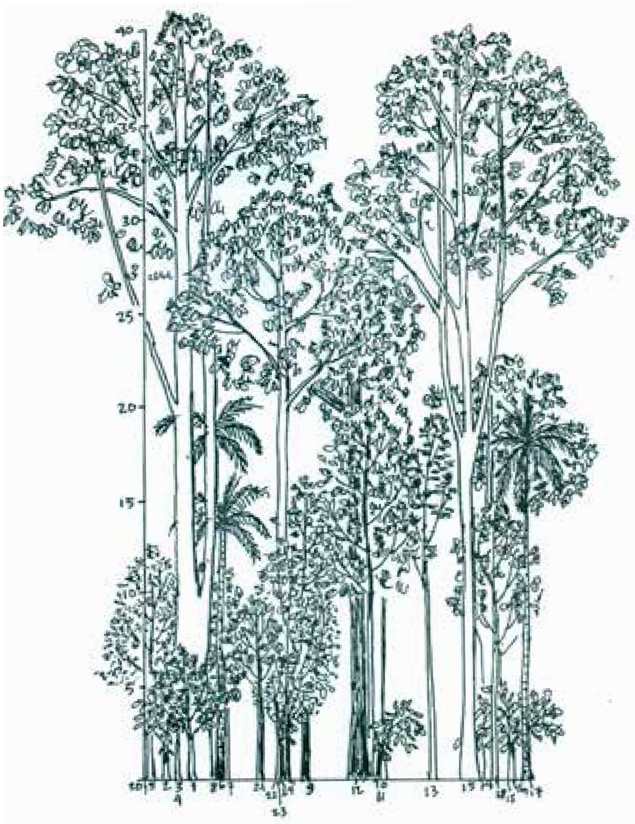

Figure 14. Sketch profile of a 20 × 20 m plot in a durian garden, Seram Island, Maluku, Indonesia. All trees with dbh ≥5 cm are depicted.

Species composition

Lower layer, 2–15 m

Theobroma cacao (cocoa) *(coklat)*: 1, 2, 10, 16, 23, 25
Syzygium aromaticum (clove) *(cengkeh)*: 5, 9
Mangifera odorata (mangga kuini): 8
Hibiscus tiliaceus (kayu baru): 13
Mangifera indica (mango) *(mangga java)*: 15
Lansium domesticum (langsat): 22

Middle layer, 15.1–25 m

Areca catechu (areca palm) *(pinang)*: 4, 6, 7, 17
Durio zibethinus (durian): 11, 12, 14, 18, 20, 21

Upper layer

Durio zibethinus (durian): 3, 19, 24

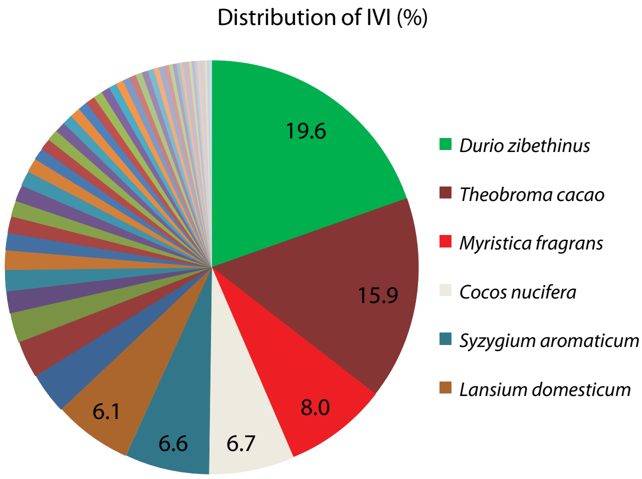

Figure 15. Importance value index (IVI) for 53 species. The six most important species are listed on the right.

3.3 Local uses of tree and other plant species

3.3.1 Local uses of species in mixed tree gardens

Among the 110 tree species inventoried in the mixed tree gardens (Appendix 5), 102 are useful: 19 species have a single use, 67 species have 2–5 uses, 15 species have 6–10 uses and just 1 species has more than 10 uses (18 uses) (Appendix 5). Only eight species are not used by the local population; all these species are spontaneous. Of the 102 useful species, 43 are planted and 59 are spontaneous. During the interviews with farmers, 24 uses were identified (Table 9).

The two uses named "cash crops" and "supplementary cash crops" apply to tree species that are used to generate cash income. *Myristica fragrans*, *Syzygium aromaticum*, *Theobroma cacao* and *Coffea canephora* are the main sources of cash income for farmers in Saleman (see the sales prices and estimates for one year of production in Appendix 6). The products are sold in a cooperative in Masohi (the closest city). Only a few people grow coffee, which plays a minor role in households' livelihoods. Another 17 species, mainly fruit trees such as *Durio zibethinus*, *Cocos nucifera* and *Mangifera indica*, may supply supplementary incomes. Farmers sell fruit in the village and sometimes in the city when yields are high.

The other uses are linked to households' subsistence needs. Three uses as construction materials were identified: "housing construction", "canoe construction" and "household furniture" with 58, 32 and 27 species, respectively. For example, *Intsia bijuga* is used for building houses, *Canarium oleosum* for building canoes and *Polyalthia lateriflora* for making furniture. In addition, 81 species are used as fuelwood, such as clove tree and *Cryptocarya densiflora*. Plants are also used for tools: people use eight species to make fishing tools (e.g. sago palm) and seven species for making rope (e.g. *Kleinhovia hospita*). Seven uses cover food supplies: staple foods

Table 9. Number of tree species for each use and proportion of planted and spontaneous species for each use.

Use category	Uses	Number of species	Proportion of planted species (%)	Proportion of spontaneous species (%)
Source of income	Cash crops	4	100	0
	Supplementary cash crops	17	94	6
Construction	Housing construction	58	26	74
	Canoe construction	32	16	84
	Household furniture	27	26	74
Fuelwood		81	38	62
Tools	Fishing tools	8	38	63
	Rope	7	43	57
Food	Staple food	5	100	0
	Fruit for food	38	84	16
	Vegetable	8	63	38
	Condiment	15	67	33
	Drink	10	70	30
	Sweetener	2	50	50
	Oil	1	100	0
Medicine		27	59	41
Cosmetic		13	62	38
Ornamental		10	90	10
Garden management	Fence	4	50	50
	Fertilizer	2	50	50
	Protection	1	100	0
Basketry		1	100	0
Ritual		4	75	25
Other		1	100	0

(5 species), fruit trees (38 species), vegetables (8 species), condiments (15 species), drinks (10 species), sugar (2 species; *Cocos nucifera* and *Arenga pinnata*) and oil (1 species). We also recorded 27 species with medicinal uses, 13 species with cosmetic uses and 10 ornamental trees. *Cocos nucifera* is used for basketry, and *Musa* sp., *Arenga pinnata* and *Areca catechu* are used in customary rituals. Saleman villagers also use three species to make fences, two species as fertilizer and one species as a shade tree. Among all the species in mixed tree gardens, the five with the most uses are: coconut palm, sago palm, banana, *Canarium oleosum* and *Areca catechu*, which have, respectively, 18, 8, 8, 8 and 7 uses. Generally speaking, we note that species used for fuelwood, construction and tools are mainly wild species (more than 50%), whereas those with other uses are mainly planted species (Table 9).

3.3.2 Other plants used by communities

During the free listing, a total of 125 other species belonging to 58 families were identified (Appendix 5). Of these, 43 are trees and 82 are herbaceous and liana species. Of tree species, 17 were sampled in small gardens surrounding houses and 26 in forests (secondary forest or *dusun*). Of the non-tree species, 24 were sampled in mixed tree gardens, 54 in small gardens surrounding houses and 14 in the forest. The analysis reveals that mixed tree gardens can contain useful herbaceous or liana species and that small gardens surrounding houses are used to grow more useful non-tree species. In summary, 235 species were inventoried, of which 227 are useful.

3.3.3 Important species for each use category

Intra-cultural variations

For the 16 categories of use (Appendix 7) studied in the free listing exercise, the number of species mentioned (using vernacular names) varied between respondents. A comparison of the mean lengths of the lists made for men and women for each use revealed significant differences for six categories of use (Appendix 8). Men named more species for the use categories “canoe construction”, “fishing tools” and “sugar” than did women, whereas women mentioned more species than men for uses as “vegetables”, “medicines” and “cosmetics”. Qualitative differences were also identified between the species mentioned by men and women. The number of shared items is low for 10 uses, for which the similarity index is ≤50%, including “housing construction”, “staple food” and “household furniture” (Appendix 9). The similarity index is higher than 60% for four use categories (“fruit for food”, “vegetables”, “condiments”, “oil” and “sugar”). Men and women cited the same items for “oil” and “sugar” (SI = 100%). The differences in list length and content highlight intra-cultural variations in local knowledge.

From highly salient to less salient species

Highly salient, salient and less salient items were identified for men and women for each use (Appendix 10). To illustrate the results, three uses are chosen.

First, for housing construction, the most salient item for both men and women was *kayu besi* (Figure 16a, b), with a high composite salience value. The local name *kayu besi* applies to two species: *Intsia bijuga* and *Pongamia pinnata*. For women, *kayu gufasa* (*Vitex cofassus*) and *kayu lenggua* (*Pterocarpus indicus*) were salient species, although less so than *kayu besi* (Figure 16a). A clear threshold is apparent between the composite salience value of the first item and the second one. Another salience threshold appears between *kayu lenggua* and the following item, which makes it possible to identify the less salient items *kayu palaka* (*Octomeles moluccana*) and durian (*Durio zibethinus*). These species were less salient, but they were mentioned by about half of the respondents. For men, *kayu gufasa* was another salient species, following the highly salient *kayu besi* (Figure 16b). For men, *kayu siki* and *kayu palaka* are less salient species. The name *kayu siki* also applies to two species: *Palaquium obovatum* and *Palaquium obtusifolium*.

Second, for the category of use “staple food”, the most salient item for both men and women was sago (*Metroxylon sagu*) followed by *singkong* (*Manihot esculenta*) (Figure 17a, b). Less salient for men were

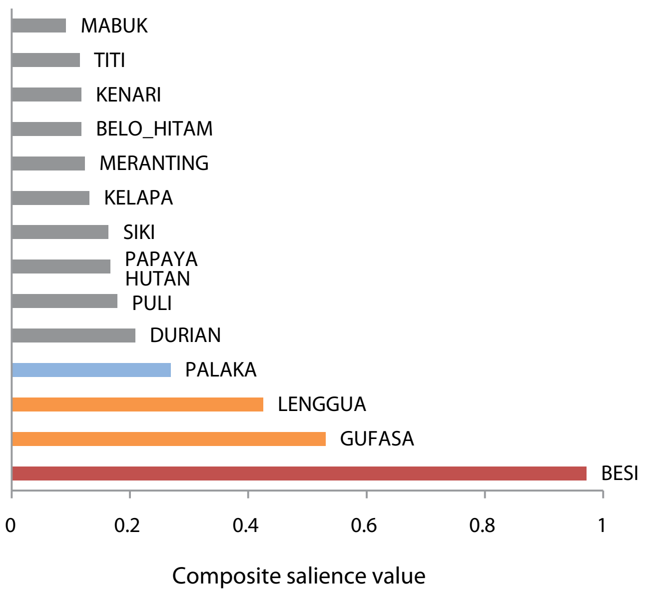

Figure 16a. Composite salience value of construction wood (women).

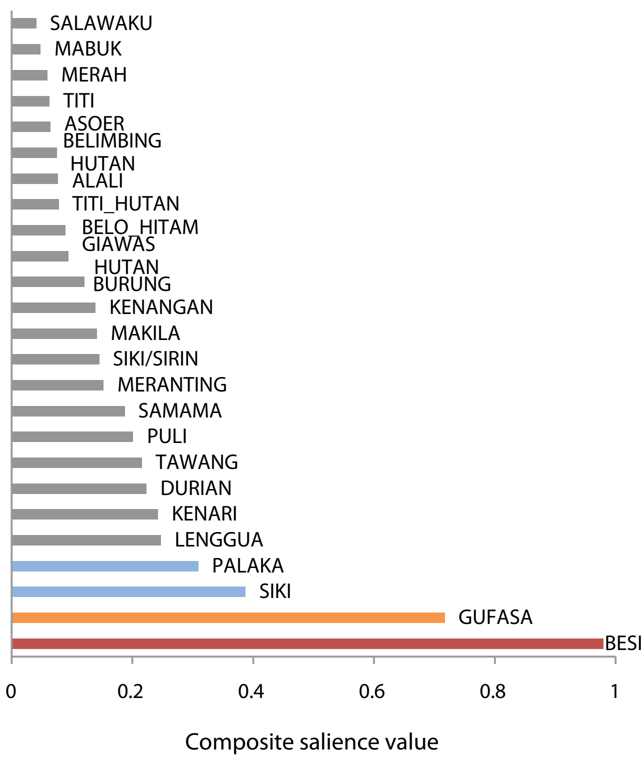

Figure 16b. Composite salience value of construction wood (men).

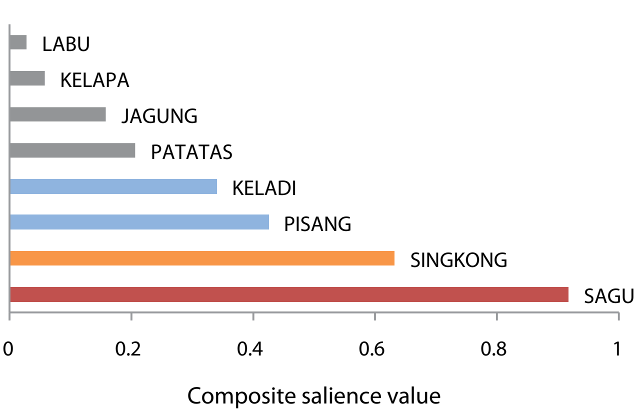

Figure 17a. Composite salience value of staple food species (women).

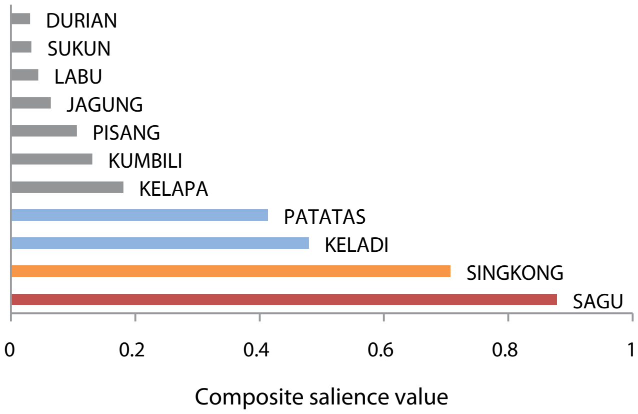

Figure 17b. Composite salience value of staple food species (men).

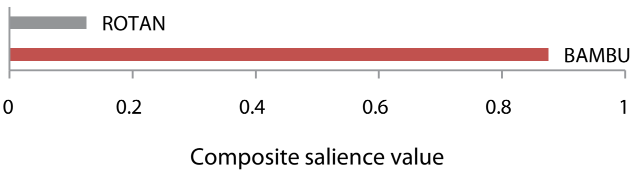

Figure 18a. Composite salience value of species used as fishing tools (women).

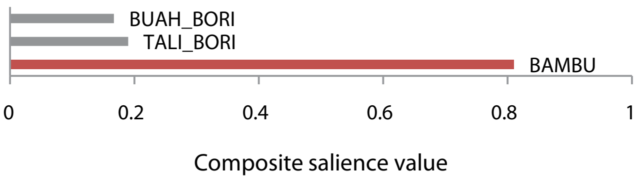

Figure 18b. Composite salience value of species used as fishing tools (men).

keladi (*Colocasia*) and sweet potato (*Ipomea batatas*) (Figure 16b) and for women, banana (*Musa* sp.) and *keladi* (Figure 17a).

Third, the only important species for fishing is bamboo, which has a very high composite salience value (Figure 18a, b). The local name *bambu* refers to several species in the Bambusoideae subfamily.

The contribution of mixed tree gardens and other land uses to livelihoods

For each use, the species identified as highly salient, salient and less salient have different characteristics in terms of growth form and origin (mixed tree gardens, small gardens or forest) (Appendix 11). Indeed, species used as construction materials, fishing tools, cosmetics, ornamentation and for making drinks are tree species found in mixed tree gardens (with the exception of *kunyit* or turmeric (*Curcuma domestica*). Species used for fuelwood are mainly found in mixed tree gardens; only two of them were sampled in the forest: *kayu pakat* (*Casearia grewiaefolia*) and *kayu sihata* (*Mallotus peltatus*). The only species used for making cooking oil, coconut, is only found in mixed tree gardens. By contrast, salient species used for vegetables and condiments are from small gardens surrounding houses. Most of these are grasses, such as *sare* (*Cymbopogon nardus*), or shrubs such as chili (*Capsicum annuum*, *Capsicum frutescens*). As a staple food, *Metroxylon sagu* is mainly extracted from managed swamp forests whereas the other important species grow in small gardens near houses. All fruit species are trees from mixed tree gardens apart from papaya (*Papaya carica*), which is grows exclusively in small gardens. Finally, the most salient medicinal plants are both from mixed tree gardens and small gardens and are herbaceous or tree species.

4. Discussion

4.1 Mixed tree gardens: An integrated land use

The village lands are composed of a mosaic of tree garden systems, secondary forests and undisturbed forests, as in many rural areas in Indonesia (Michon et al. 1986; Hariyadi and Ticktin 2012). In the past, there were some upland paddy fields (*ladang*) around the village, as in other parts of west Seram (Ellen 1993), but Saleman farmers have abandoned this practice. The land-use system is still controlled by customary (*adat*) law. The village land is divided among clans and its management is regulated by customary practices that are still widespread in Maluku (Ellen 1985).

Both categories of garden in Saleman are agroforestry systems. Small gardens, *kebun kecil* or *aka kiiti*, which are planted near houses and include fruit trees and mainly herbaceous species consumed by the household, are comparable to the home gardens (Kumar and Nair 2004; Kabir and Webb 2009) that are common in Java and Sulawesi (Christanty et al. 1986; Kehlenbeck and Maass 2004). However, not all households have a small garden. Indeed, this kind of land use seems to be a minor component of the land-use system. One reason may be the lack of available land between houses or near the village (since the expansion of the village in the past 20 years) or the soil fertility, given that the village is on the sandy beach front.

The second type of garden is the mixed tree garden, *kebun besar* or *aka maina*. These gardens are established by clearing a patch of forest and planting tree seedlings. The slashed plot is not systematically burned before cropping and farmers do not use fertilizer. Indeed, fertility is ensured through natural nutrient cycling processes, which constitute one of the characteristics of complex agroforestry systems (Michon et al. 1986; Wiersum 2004; Belcher et al. 2005). In the past, the practices were different; in recent decades, farmers have stopped planting food crops in the first phase of establishing a new tree garden. This change is associated with the abandonment of rice fields. One reason may be the increasing need for cash, which induces farmers to plant trees immediately and focus their efforts on cultivating commercial crops. Another factor may be that access to markets to sell commercially valuable products started to get easier in the 1980s (Ellen 1997, 1999), around the same time that new cash crops, such as cocoa, were introduced (Clough et al. 2009).

These smallholders' tree plantations integrated into the forested landscape around the village are private plots owned by the farmers, as far as customary laws are concerned. In several other regions in Indonesia, such as in Sumatra near Kerinci Seblat National Park, where lands are historically under customary laws and owned by clans, land tenure gradually shifted from land as common property to private property when cash crops were introduced into tree garden systems (Belcher et al. 2005; Hariyadi and Ticktin 2012). In addition, these mixed tree gardens have become a source of conflict with Manusela National Park authorities. Similar conflicts between park authorities and local populations on the periphery of conservation areas have been recorded in many areas in Indonesia (Aumeeruddy and Sansonnens 1994; Murniati et al. 2001; Hariyadi and Ticktin 2012). Before the creation of the park boundaries in 1997, 600 ha of mixed tree gardens had already been established in the area. Since then, farmers continue to make new gardens, especially given that the boundaries are not clear (the original boundaries were marked with concrete posts whereas the new boundaries are marked by wooden sticks only). In this context of conflict, the expansion of gardens may actually ensure "property rights" when planting trees is a means of securing long-term use rights to a plot of land (Michon 2003).

4.2 Mixed tree gardens: Complex agroforestry systems similar to natural forest

The mixed tree gardens are multistoried, with 2–4 layers. As in other parts of Indonesia, durian gardens have the most complex structure (Michon et al. 1986). The less complex cocoa gardens are not shaded. Similarly, in Sulawesi, many smallholder cocoa plantations are not shaded and present a simple structure because farmers remove the tree cover to increase yields (Clough et al. 2009). The dominant species in the mixed tree gardens of Saleman are also dominant in the *dusun* system of Saparua Island studied by Kaya et al. (2002). Indeed, agroforestry systems across Maluku show several similarities.

A comparison of the 1 ha sampled mixed tree gardens and 1 ha lowland forest on limestone in Seram (Ranlund 2011) reveals that the density of trees (dbh ≥ 10 cm) in mixed tree gardens (428) is close to the density in primary forest (438). However, the total basal area is clearly higher in primary forest. As for species richness, 95 tree species were found in primary forest and 45 species in gardens (25 plots). In another study of lowland forests in Seram, 17–54 species were inventoried in 0.25 ha plots (Edwards et al. 1993). Indeed, the phytomass and species richness are lower in mixed tree gardens. However, at garden scale, a total of 110 species were identified in 22 gardens belonging to 42 families. These results highlight the usefulness of sampling for the assessment of species richness and the possible impact of farmers' choices and practices on the spatial distribution of species. Some species are always planted or grow spontaneously inside the garden borders. A plot selected in the middle of the garden cannot provide samples of all species. Finally, our findings suggest that the high floristic similarity observed between durian and clove gardens is due to local agroforestry practices and farmers' choices.

4.3 Importance of mixed tree gardens for the local population

The mixed tree gardens, with 110 useful tree species and 24 useful liana and herbaceous species, can supply fruit, medicine, timber, vegetables or a source of cash income, as is the case for many tree garden systems across Sumatra, Java and Sulawesi (Michon et al. 1986; Brodbeck et al. 2003; Manurang et al. 2004; Okubo et al. 2010). The three cash species, *Theobroma cacao*, *Syzygium aromaticum* and *Myristica fragrans*, are the main source of income for Saleman farmers, just as *Hevea brasiliensis* (Gouyon et al. 1993) and *Shorea javanica* are for farmers in Sumatra. Mixed tree gardens thus play a major role in the self-subsistence of farmers' households by supplying fuelwood (81 species), wood for housing construction (58 species), medicines (27 species) or fruit (38 species). These results confirm that complex agroforestry systems make a major contribution to the self-subsistence of rural households, as already identified in other tree-based systems in Indonesia (Christanty et al. 1986; Michon et al. 1986; Gouyon et al. 1993; Brodbeck et al. 2003; Okubo et al. 2010).

However, mixed tree gardens cannot provide enough for all types of livelihoods. Other land uses supply complementary products or incomes. The small gardens surrounding houses are the main source of vegetables, condiments and staple food. They also supply medicinal plants and fruit for daily consumption. Natural forest and managed forest such as *dusun sagu* also supply useful species and contribute to rural livelihoods (Sunderlin et al. 2005). *Dusun dammar*, another example of managed forest habitat, also contribute to cash incomes, even though the market has fluctuated. My findings confirm that the mixed tree gardens are integrated into an overall land-use system, complementing, and complemented by, other land uses (Wiersum 2004; Belcher et al. 2005). However, some products are bought, especially rice, which people eat every day. Saleman villagers use the cash they make from their mixed tree gardens to buy staple food.

4.4 Mixed tree gardens inside Manusela National Park

A local challenge is to reconcile the management of the conservation area with the social and economic needs of the local population. The mixed tree gardens inside the boundaries of Manusela National Park are characterized by a more or less complex forest-like structure and account for an appreciable number of wild tree species. Indeed, these gardens may provide an opportunity to conserve wild tree species outside the natural forest and provide diverse habitats for wild fauna (birds, mammals or insects) and plant species (lianas, epiphytes, herbaceous plants). Several studies have shown the potential of agroforests to conserve biodiversity (Michon and de Foresta 1995, 1996; Beukema et al. 2007; Bos et al. 2007). A solution to the present conflicts could be to promote these agroforestry systems as a buffer zone, restricting further access into the park (Aumeeruddy and Sansonnens 1994; Murniati et al. 2001), that is, as a transition zone between the park and the surrounding villages.

5. Conclusion

The results of this study demonstrate that the tree garden systems on Seram Island are another example of a reconstructed forest made by farmers in tropical areas. These tree gardens, characterized by a multistoried structure and high species richness, play a key role in the economy of Saleman farmers. The two main socioeconomic functions of mixed tree gardens are to provide a cash income and to supply the forest products that are essential for poor rural communities. This land use is not isolated, but is integrated into a complex land-use system where each land use serves certain socioeconomic functions and complements the others. By providing diverse habitats for wild species (both plants and animals), mixed tree gardens could serve as a buffer zone between the park and the surrounding villages, which may help resolve residents' conflicts with the Manusela National Park authorities. It would be interesting to study the potential these gardens have for the conservation of wild fauna, or other taxa, and their role in the provision of ecosystem services. In the framework of the CoLUPSIA project, the results, taken in conjunction with previous studies in other villages around Manusela National Park, may offer interesting suggestions for conducting land-use planning that takes into account the priorities of local people.

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Appendices

Appendix 1. Questionnaire used for interviews with farmers.

Respondent:	:						
Date:	:						
Age:	:						
Sex:	:						
Attributes of the mixed tree garden							
Type of garden:	:	*Cocoa	*Coconut	*Clove	*Durian	*Nutmeg	
Location name:	:						
Clan:	:						
Size:	:						
Age:	:						
Type of soil:	:						
Boundary:	:	*Fence	*Planted trees	*Wild trees	*Others		
How garden came under ownership:	:	*Inheritance	*Forest clearing	*Purchase	*Rent		
Do you have other gardens?	:	*Yes	*No				
If yes, which type of garden?	:	*Cocoa	*Coconut	*Clove	*Durian	*Nutmeg	
Establishment and management of mixed tree gardens							
A. Establishment of a new garden							
Explain step by step how to make a new garden from clearing the forest to planting seeds/seedlings.	:						
How long after clearing the forest do you plant seeds/ seedlings?	:						
Origin of seeds/seedlings:	:						
First fruiting period:	:						
B. Farming practices:							
Usual activities in gardens:	:	*Planting	*Clearing	*Cutting	*Weeding	*Harvesting	*Other
Use of fertilizer:	:	*Yes	*No				
Presence of pests/diseases:	:	*Yes	*No				
How to remove pests and diseases?	:						
C. Production of main cash crops (for one garden)							
Number of harvest periods per year:	:						
Yield per harvest period:	:						
Location of market for produce:	:						
Sale prices:	:						
D. Local uses of tree species:							
For each tree species present in the gardens, respondents were asked about the following:	:						
Life form:	:						
Local names in Indonesian:	:						
Local names in Bahasa Saleman:	:						
Local uses:	:						
Preparation:	:						
Notes:	:						

Appendix 2. 29 species known only by their vernacular names and not possible to sample.

Vernacular names in Indonesian	Vernacular names in Bahasa Saleman	Notes	Vernacular names in Indonesian	Vernacular names in Bahasa Saleman	Notes
Benteng	–	Tree	*Kayu kuning/ mengkudu*	*Ai kuni*	Tree
Buah botol	–	–	*Kayu makila*	*Ai awarela*	Tree
Bunga kamboja	–	–	*Kayu manggi manggi*	*Ai aati*	Tree
Bunga melati	–	–	*Kayu manggi manggi*	*Ai palun*	Tree
Daun biana		Lamiaceae	*Keladi hutan*	–	Araceae
Daun bobo	–	Palm	*Kersen*	–	Tree
Daun dilan	–	–	*Kisasi*	–	Generic name for epiphytes ferns
Daun gaga	–	–	*Lemon suanggi*	*Usi hirin*	Tree
Daun galiji	–	–	*Obat gunung*	–	Herbaceous
Daun santang	–	–	*Paha*	–	Pandanaceae
Daun suplir	–	–	*Pohon galoba hutan*	–	–
Daun tikar	*Buri buri*	Pandanaceae	*Rumput teki*	–	–
Jambu kenop	–	Tree	*Tali cincin*	–	Liana
Kayu asoer	–	Tree	*Tali rumah*	*Ayaa luman*	Liana
Kayu kira kira	–	Tree	*Tali ruri*	–	Liana

Appendix 3. Local management practices for the five main species in tree gardens.

Species	Origin of seeds and/or seedling	First fruiting period (age in years)	Disease/ pests	Practices to eradicate disease/pests	Fertilizer
Theobroma cacao	Seeds harvested from mature cocoa trees/seedlings harvested in gardens	2 to 3	Yes	Fire	No
Cocos nucifera	Seedlings from Pulau Tujuh (island near Saleman)	5 to 7	Yes	Fire	No
Myristica fragrans	Seedlings from East Seram or harvested in gardens/seeds harvested from mature nutmeg trees	5 to 7	No	–	No
Syzygium aromaticum	Seeds harvested from mature clove trees	6 to 7	Yes	Fire	No
Durio zibethinus	Seeds harvested on durian trees	15	No	–	No

Appendix 4. Dominant and most abundant species in each layer.

	Cocoa gardens				Coconut gardens				Clove gardens			
	Dominant species	**Rdo (%)**	**Most abundant species**	**Rde (%)**	**Dominant species**	**Rdo (%)**	**Most abundant species**	**Rde (%)**	**Dominant species**	**Rdo (%)**	**Most abundant species**	**Rde (%)**
Lower layer, 2–7 m	*Theobroma cacao*	73	*Theobroma cacao*	83	–	–	–	–	*Theobroma cacao Syzygium aromaticum*	65	Theobroma cacao Syzygium aromaticum	66
Low layer, 7.1–15 m	–	–	–	–	–	–	*Cerbera floribunda*	20	*Syzygium aromaticum*	44	Syzygium aromaticum	37
Middle layer, 15.1–25 m	–	–	–	–	*Cocos nucifera*	73	*Cocos nucifera*	82	–			
Upper layer, >25 m	–	–	–	–	–	–	–	–	–			

	Durian gardens				Nutmeg gardens			
	Dominant species	**Rdo (%)**	**Most abundant species**	**Rde (%)**	**Dominant species**	**Rdo (%)**	**Most abundant species**	**Rde (%)**
Lower layer, 2–7 m	*Theobroma cacao*	82	*Theobroma cacao*	56	-		-	
Low layer, 7.1–15 m	*Syzygium aromaticum Areca catechu*	64	*Syzygium aromaticum Areca catechu Lansium domesticum*	57	*Myristica fragrans*	61	*Myristica fragrans*	58
Medium layer, 15.1–25 m	*Durio zibethinus Syzygium aromaticum*	91	*Durio zibethinus Syzygium aromaticum*	70	*Myristica fragrans*	49	*Myristica fragrans*	66
Upper layer, >25 m	*Durio zibethinus*	100	*Durio zibethinus*	100	-		-	

Note: Rdo = relative dominance; Rde = relative density.

Appendix 5. List of all plant species inventoried.

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Tree species in mixed tree gardens						
Aglaia sapindina Harms	Melliaceae	*Langsa hutan*	*Ai Mahu wapa*	T	FW	1
Alangium javanicum (Blume) Wang.	Alangiaceae	*Kayu gufasa talaga / gufasa Ternate*	*Ai Laharu*	T	HC, FW, HF	3
Alstonia scholaris (L.) R.Br.	Apocynaceae	*Kayu puli / pule*	*Ai Itun*	T	HC, CaC, FW, HF, FT, Me	6
Annona muricata L.	Annonaceae	*Nangka Belanda /Sirsak*	*Duria Arata*	T	SCC, FW, FF, Dr, Me	5
Anthocephalus macrophyllus Havil.	Rubiaceae	*Kayu samama*	*Ai Kimama*	T	HC, CaC, FW	3
Aphanamixis polystachya (Wall.) R.N. Parker	Melliaceae	*Kayu mabuk*	*Ai museni*	T	HC, CaC, FW, HF, Me	5
Aquilaria versteegii H. Hallier	Thymelaeaceae	*Kayu gaharu*	–	T	Oth	1
Areca catechu L.	Arecaceae	*Pinang*	*Hua*	T	SCC, HC, HF, FF, Me, Or, Ri	7
Arenga pinnata (Wurmb) Merr.	Arecaceae	*Pohon Aren*	*Pohon Gamutu/Ai La*	T	HC, HF, Ro, FF, Dr, Su, Ri	7
Artocarpus altilis (Parkinson) Fosberg	Moraceae	*Sukun*	*Ai Suun*	T	HC, CaC, FW, FT, SF, FF, Veg, Me	8
		Sukun hutan	*Ai Ulun*			
Artocarpus heterophylla Lam.	Moraceae	*Nangka bubur*	–	T	SCC, FW, FF, Ve	4
		Nangka salak	–			
Artocarpus integra Merr.	Moraceae	*Campedak/Campadak*	*Laka Laka*	T	FW, FF	2
Averrhoa carambola L.	Oxalidaceae	*Belimbing manis*	–	A	FF	1
Averroha bilimbi L.	Oxalidaceae	*Belimbing asam*	–	T	FW, FF, Co	3
Barringtonia sp.	Lecythidaceae	–	*Ai Hutun*	T	HC, FW, Co, Dr	4
Buchanania arborescens (Blume) Blume	Anacardiaceae	*Jambu Meteng hutan*	–	T	FW	1
Buchanania macrocarpa Lautrb.	Anacardiaceae	*Ketapang hutan*	*Ai Kaea*	T	HC, CaC, FW	3
Calophyllum soulattri Burm.f.	Clusiaceae	*Bintanggur/ Bintanggur hitam*	*Ai taun*	T	CaC, FW	2
Cananga odorata Hook.f. & Thoms.	Annonaceae	*Kayu kenangan*	*Ai Sipalin*	T	HC, CaC, HF, FT, Cos	5
Canarium oleosum (Lamk) Engl.	Burseraceae	*Kayu kenari / kanari*	*Ai Iyan*	T	SCC, HC, CaC, FW, HF, FF, Co, Me	8
Caryota rumphiana Mart.	Arecaceae	*Pohon Nibung*	*Koran*	T	HC, HF	2

Appendix 5... Continued

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Cerbera floribunda K. Schum	Apocynaceae	*Kayu mata buta*	*Leka leka*	T	FW	1
Cinnamomum verum J.S.Presl.	Lauraceae	*Kayu manis*	*Ai Mulele*	T	Co	1
Citrus aurantifolia Swingle	Rutaceae	*Lemon cina*	*Usi sina / Usi timun*	T	SCC, FW, FF, Co, Me	6
		Lemon nipis/ Jeruk nipis	*Usi timun*			
Citrus maxima Merr.	Rutaceae	*Lemon manis buah besar*	*Usi Alata / Usi Mulele maina*	T	FF, Co	2
		Lemon papeda	*Usi Kamasi*			
Citrus nobilis Lour.	Rutaceae	*Lemon manis buah kecil*	*Usi mulele biasa / Usi Mulele kiiti*	T	SCC, FW, FF, Co, Dr	5
Cocos nucifera L.	Arecaceae	*Pohon kelapa*	*Luin*	T	SCC, HC, FW, HF, FT, Ro, SP, FF, Ve, Co, Dr, Su, Oi, Me, Cos, Or, Ba, Ri	18
Codiaeum variegatum Blume	Euphorbiaceae	*Gadihu*	–	T	Or	1
Coffea canephora Pierre var Robusta Chevai	Rubiaceae	*Kopi*	–	T	CC, FW, FF, Dr	4
Colona scabra Burret	Tiliaceae	*Kayu marong*	*Ai Huluti*	T	HC, CaC, FW, Ro	4
Cordia myxa Forsk.	Boraginaceae	*Kayu semang*	*Ai Alupun*	T	HC, CaC, FW, FT	4
Cryptocarya densiflora Blume	Lauraceae	*Kayu samar putih / kayu samarang*	*Ai rola masahun putih*	T	HC, FW	2
Cynometra cauliflora L.	Fabaceae	*Namu Namu*	*Lambuti*	T	FW, FF	2
Dalbergia sp.	Fabaceae	*Kayu Salawaku*	–	T	HC, CaC, FW, Fer	4
Decaspermum bracteatum (Roxb.) A.J. Scott.	Myrtaceae	*Kayu merah daun halus*	*Ai musina*	T	FW	1
Dendrophthoe falcata (L.f) Danser	Loranthaceae	*Benalu*	*Ai Manunpang*	T	Me	1
Diospyros korthalsiana Hiern.	Ebenaceae	*Kayu belo hitam*	*Alametin*	T	HC, FW, HF	3
Diospyros pilosanthera Blanco	Ebenaceae					
Durio zibethinus Murr.	Bombacaceae	*Durian*	–	T	SCC, HC, CaC, FW, HF, SF, FF	7
Dysoxylum densiflorum (Blume) Miq.	Meliaceae	*Kayu mabuk*	*Ai museni*	T	HC, CaC, FW, HF, Me	5
Endospermum moluccanum Becc.	Euphorbiaceae	*Kayu Raja/ Kayu Semut*	*Ai Kineri*	T		0
Erythrina variegata L.	Fabaceae	*Galala/Kayu dadak*		T	HC, Co	2
Ficus copiosa Steud.	Moraceae	*Gohi*	*Kayohiti*	T	Ve	1
Ficus congesta Roxb.	Moraceae	*Pohon Gondal buah kecil*	*Ai Mosu*	T		0

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Ficus lepicarpa Blume	Moraceae	*Sirih Popa*	*Asapulan*	T	HC, FW	2
Ficus septica Reinw. ex Blume	Moraceae		*Asapulan*	T		0
Ficus subulata Blume	Moraceae	*kayu beringin*	*Waringin/Ai Lulu*	T	FW, Ro, Co	3
Ficus variegata Blume	Moraceae	*Pohon gondal buah besar*	*Ai Mosu*	T	HC, CaC, FW, Me	4
Flacourtia rukam Zoll.& Mor.	Flacourtiaceae	*Tomi Tomi*	*Tom Tom*	T	FW, FF, Co, Or	4
Garcinia mangostana L.	Clusiaceae	*Manggis/Mangustan*	–	T	SCC, FW, FF, Me, Cos	5
Garcinia tetrandra Pierre	Clusiaceae	*Manggis hutan/Mangustan hutan*	*Tainuhun*	T	HC, FW, Co	3
Geunsia pentandra (Roxb.) Merr.	Verbenaceae	*Kayu tembakau hutan*	*Ai tabaku*	T	Fw	1
Gliricidia sepium H.B.K.	Fabaceae	*Pohon pelindung /Kayu hidup*	–	T	FW, Fe, Fer, Pt	4
Gmelina moluccana Backer ex K.Heyne	Verbenaceae	*Kayu titi Pantai*	*Ai Pain*	T	HC, CaC, FW, HF	4
Gnetum gnemon L.	Gnetaceae	*Ganemon*	*Ai Kirama*	T	FW, Ve	2
Gulubia costata Becc.	Arecaceae	*Pinang hutan*	*Mapua*	T	HF,	1
Hibiscus tiliaceus Linn.	Malvaceae	*Kayu Baru*	*Ai Halun*	T	HC, CaC, FW, Me	4
Homalium foetidum Benth.	Flacourtiaceae	*Kayu samar / Kayu Samarang*	*Ai rola masahun*	T	HC, CaC, FW, HF	4
Horsfieldia bivalvis Merr.	Myristicaceae	*Lobi lobi buah kecil/lobi lobi makan*	*Topi Topi*	T	HC, FW, FF	3
Horsfieldia sylvestris Warb.	Myristicaceae	*Lobi lobi buah besar/Lobi lobi hutan*	*Topi Topi kamuka*	T	HC, CaC, FW	3
Hydnocarpus sp.	Flacourtiaceae	*Gayang hutan*	*Ai Ka*	T		0
Inocarpus fagiferus (Parkinson) Fosberg.	Fabaceae	*Gayang pantai*	*Ai Ka*	T	HC, FW, FF	3
Intsia bijuga Kuntze	Fabaceae	*Kayu besi*	*Ai Tolati*	T	HC, CaC, FW, HF	4
Jatropha curcas	Euphorbiaceae	*Jarak pagar*	*Ai Latu*	T	FW, Me	2
Kleinhovia hospita Linn.	Sterculiaceae	*Kayu kinar*	*Ai Lohan*	T	HC, FW, Ro, Me, Or, Fe	6
Lansium domesticum Corr.	Meliaceae	*Langsa*	*Ai Mahu*	T	SCC, FW, FF, Me, Cos, Or	6
Laportea decumana Wedd.	Urticaceae	*Daun Gatal*	*Sinan*	T	Me	1
		Kayu daun gatal	*Ai sinatan*			
Leea indica Merr.	Leeaceae	–	*Alapakan berduri*	T		0
Litsea diversifolia Blume	Lauraceae	*Alpukat hutan*	–	T	FF	1

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Appendix 5... Continued

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Macaranga hispida Muell. Arg.	Euphorbiaceae	*Hanua*	*Ai Hulua*	T	HC, FW	2
Mallotus ricinoides Muell. Arg.	Euphorbiaceae	*Kayu kapur*	*Ai Losa*	T	Me	1
Mangifera indica L.	Anacardiaceae	*Mangga Biasa/Pantai/Buah Kecil/ Isap/Java/ Mangga golek*	*Ai papalam*	T	SCC, HC, FW, FF, Dr, Cos, Or	7
Mangifera laurina Blume	Anacardiaceae	*Mangga hutan/asam*	*Aun*	T	HC, CaC, FW, FF	4
Mangifera odorata Griff.	Anacardiaceae	*Mangga Kuini*	*Kuin*	T	SCC, HC, FF, FW Cos	5
		Bacang/Becang	*Pati*			
Manihot esculenta Crantz.	Euphorbiaceae	*Singkong*	*Kasbi*	T	FW, SF, FF, Ve	4
Metroxylon sagu Rottb.	Arecaceae	*Pohon sagu*	*Hatan*	T	HC, HF, FT, Ro, SF, FF, Or, Fe	8
Musa sp.	Musaceae	*Pisang*	*Uri*	T	FT, Ro, SF, FF, Ve, Me, Or, Ri	8
Mussaenda reinwardtiana Miq.	Rubiaceae	*Kayu Ge/Bunga Kupu kupu*	–	T	Oth	1
Myristica fatua Houtt.	Myristicaceae	*Pala hutan buah besar/Pala hutan*	–	T		0
Myristica fragrans Houtt.	Myristicaceae	*Pala*	–	T	CC, FW, FF, Co, Me, Or	6
Neonauclea moluccana Merr.	Rubiaceae	*Kayu kasa*	*Kimasi mula*	T	HC, FW, Cos	3
Nephelium lappaceum L.	Sapindaceae	*Rambutan*	–	T	SCC, FW, FF	3
Neuburgia moluccana (Scheff.ex Boerl.) Leenh.	Loganiaceae	*Jati hutan*	–	T	HC, FW	2
Octomeles moluccana Teijsm. & Binn. ex Hassk	Datiscaceae	*Kayu palaka / pulaka*	*Ai Puraran*	T	HC, CaC, FW, HF	4
Palaquium obovatum Engl.	Sapotaceae	*Kayu siki*	*Ai Sirin*	T	HC, CaC, FW, HF	4
Persea americana Mill.	Lauraceae	*Alpukat*		T	FF, Dr, Me, Cos	4
Pertusadina multifolia (Havil.) C.E. Ridsdale	Rubiaceae	*Kayu nisan*	*Ai Losuti/Ai Mahalu*	T	HC, CaC, FW, FT	4
Piper aduncum L.	Piperaceae	*Sirih Hutan*	*Ai Kamu*	T		0
Podocarpus neriifolia D.Don	Podocarpaceae	*Kayu Cina*	–	T	HC, FW, HF	3
Polyalthia lateriflora King	Annonaceae	*Kayu meranting*	*Ai loren*	T	HC, CaC, FW, HF, Fe	5
Pongamia pinnata Merr.	Fabaceae	*Kayu besi pantai*	*Ai Awasan*	T	HC, FW	2
Premna sp.	Verbenaceae	*Kayu titi hutan*	*Ai Lusan*	T	HC, CaC, FW, HF	4

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Psidium guajava Linn.	Myrtaceae	*Giawas/Jambu batu/Jambu biji*	–	T	SCC, FW, FF, Dr, Me	5
Pterocarpus indicus Willd.	Fabaceae	*Kayu lenggua*	*Ai Lalan*	T	HC, CaC, FW, HF, Cos	5
Pterocymbium tinctorium (Blanco) Merr.	Sterculiaceae	*Kayu kalabasa hutan*	*Ai Kalabasa apa*	T	HC, FW	2
Salacca zalacca (Gaertn.) Voss	Arecaceae	*Salak*	–	T	SCC, FF	2
Semecarpus forstenii Blume	Anacardiaceae	*Ninat*	*Ai Ninati*	T	FW	1
Spondias cytherea Sonnerat	Anacardiaceae	*Kedongdong*	–	T	HC, CaC, FW, FF, Me	5
Syzygium aqueum Alston	Myrtaceae	*Jambu Air*	*Poputi*	T	SCC, HC, FW, FF, Me	5
Syzygium aromaticum (L.) Merr. & Perry	Myrtaceae	*Cengkeh*	–	T	CC, FW, FF, Co, Me	5
Syzygium malaccense (L.) Merr.& Perry	Myrtaceae	*Jambu Makui / Makui talukun*		T	SCC, HC, FW, FF, Cos	5
		Makui talukun	–			
Syzygium sp.	Myrtaceae	*Kayu meran*	*Ai musina*	T	HC, CaC, FW, HF	4
Tectona grandis L.f.	Verbenaceae	*Jati mas*	–	T	HC, CaC, FW, HF	4
Terminalia catappa L.	Combretaceae	*Ketapang pantai*	*Ai Tanisa*	T	HC, CaC, FW, FF, Me, Cos	6
Terminalia microcarpa Decne	Combretaceae	*Kayu alali*	*Ai Alali*	T	HC, CaC, FW, Ve, Co, Dr	6
Theobroma cacao L.	Sterculiaceae	*Coklat*	–	T	CC, FW, FF	3
Trevesia sundaica Miq.	Araliaceae	*Kayu gurita*	*Ai Kunita*	T	Me	1
Rhus taitensis Guill.	Anacardiaceae	*Belimbing hutan*	*Leusaki*	T	FW	1
Uvaria littoralis Blume	Annonaceae	*kayu kasa*	*Kimasi mula*	T	HC, FW, Cos	3
Vitex cofassus Reinw. ex Blume	Verbenaceae	*Kayu gufasa / gufasa biasa*	*Ai Pasan*	T	HC, CaC, FW, HF, FT	5
Other plant species used by the local population						
Tree species						
Aleurites moluccana Willd.	Euphorbiaceae	*Kayu kamiri*	*Ai Hau*	T	HC, FF, Co	3
Annona reticulata L.	Annonaceae	*Buah nona*	–	T	FF	1
Annona squamosa L.	Annonaceae	*Sirih Kaya*	–	T	FF	1
Artocarpus teysmannii Miq.	Moraceae	*Nangka hutan*	–	T	PC	1
Bougainvillea sp.	Nyctaginaceae	*Bugen fil*	–	T	Or	1
Carica papaya L.	Caricaceae	*Papaya*	*Uri mahu*	T	FF, Ve, Dr, Me, Cos	5
Casearia grewiaefolia Vent.	Flacourtiaceae	–	*Ai Pakat*	T	FW	1

Continued to next page

Appendix 5... Continued

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Casuarina equisetifolia Blanco	Casuarinaceae	*Kasawari*	–	T	Or	1
Ceiba pentandra (L.) Gaertn.	Bombacaceae	*Kapok hutan*	*Ai Kapusi yapa*	T	Me	1
Chrysophyllum roxburghii G. Don	Sapotaceae	–	*Ai lolan*	T	HC, FW	2
Citrus hystrix OC.	Rutaceae	*Lemon purut*	*Usi matatahi*	T	Co	1
Citrus medica L.	Rutaceae	*Lemon papaya*	–	T	Co	1
Clerodendrum floribundum R.Br.	Verbenaceae	*Pohon Matel*	–	T	Ve	1
Duabanga moluccana Blume	Sonneratiaceae	*Giawas hutan*	*Ai Inotu*	T	HC, CaC	2
Eugenia polyantha Wight	Myrtaceae	*Daun Salam*	–	T	Co	1
Fagraea racemosa Jack	Loganiaceae	*Kopi hutan*	–	T	FW	1
Ficus sp.	Moraceae	*Kayu Ulit*	*Ai Uliti*	T	FW, FF	2
Gastonia serratifolia (Miq.) W.R.Philoson	Araliaceae	*Kayu patatulan*	*Ai patatulan*	T	FW	1
Graptophyllum pictum Griff.	Acanthaceae	*Alipuru*	–	T	Or	1
Hydnophytum formicarum Jack	Combretaceae	*Posi posi*	*Ai Uloati*	T	HC	1
Koordersiodendron pinnatum Merrill	Anacardiaceae	*Belimbing hutan*	*Ai Selang*	T	HC, FW	2
Lawsonia inermis L.	Lythraceae	*Pohon pacar*	*Ai Naka*	T	Cos	1
Leea indica Merr.	Leeaceae	–	*Alapakan tidak berduri*	T		0
Macaranga involucrata (Roxb.) Baill.	Euphorbiaceae	*Kayu hurori*	*Ai Hurori*	T	FW	1
Mallotus peltatus Muell. Arg.	Euphorbiaceae	*Kayu sihata*	*Ai Sihata*	T	FW	1
Maranthes corymbosa Blume	Chrysobalanaceae	*Kayu mas*	–	T	FW	1
Moringa pterygosperma Gaertn.	Moringaceae	*Kelor*	–	T	Ve, Me	2
Palaquium obtusifolium Burck.	Sapotaceae	*Kayu siki*	*Ai Teha*	T	HC	1
			Ai tolu			
Phaleria capitata Jack	Thymelaeaceae	*Pohon Jiba*	*Gaharu buaya*	T	Ro	1
Phyllanthus microcarpus Muell. Arg,	Euphorbiaceae	*Kartok*	–	T	Ve	1
Planchonella obovata H.J.Lam	Sapotaceae	*Kayu Hitam*	*Ai Eta*	T	FW	1
Polyalthia rumphii (Blume) Merr.	Annonaceae	*Kayu pelasun*	–	T	HC, FW	2
Pometia pinnata J.R.& G.Forst.	Sapindaceae	*Tawang*	*Ai Taan*	T	HC, FW, HF	3
Sauropus androgynus Merrill	Euphorbiaceae	*Kartok*	–	T	Ve	1
Scaevola sericea Forst. f.	Goodeniaceae	*Papaceda*	–	T	FW, Me	2

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Sesbania grandiflora (L.) Poir.	Fabaceae	*Kayu turi*	*Ai Turi*	T	Me	1
Sindora galedupa Prain	Fabaceae	*Kayu minyak*	–	T	HC, CaC, FW, HF, Me	5
Sterculia macrophylla Vent.	Sterculiaceae	*Papaya hutan*	–	T	HC, HF	2
Syzygium samarangense (Blume) Merr. & Perry	Myrtaceae	*Jambu mawar*	–	T	FW, FF, Me	3
Tamarindus indica L.	Fabaceae	*Asam Java*	–	T	HC, FW, FF, Co, Me, Cos	6
Syzygium sp.	Myrtaceae	*Jambu hutan*		T	FW, FF	2
Agathis dammara (Lamb.) Rich.	Araucariaceae	*Agathis/ pohon damar*	–	T	HC, FW, Ve	3
Non–tree species						
Acalypha indica Linn.	Euphorbiaceae	*Daun pus*	–	H	Me	1
Adenia heterophylla (Blume) Koord.	Passifloraceae	*Matel maraya*	–	L	Ve	1
Adenia sp.	Passifloraceae	*Patola ular*	–	L	Ve	1
Aglaonema sp.	Araceae	*Sri Rejeki*	–	H	Or	1
Alpinia galanga (L.) Willd.	Zingiberaceae	*Lengkuas merah*	–	H	Co, Me	2
Alpinia sp.	Zingiberaceae	*Lengkuas putih*	–	H	Me	1
Amaranthus hybridus Linn.	Amaranthaceae	*Bayam*	–	H	Ve	1
Anamirta cocculus (L.) Wight & Arn.	Menispermaceae	*Buah bori*	*Simuliti huan*	L	FT, Cos	2
Ananas comosus (L.) Merr.	Bromeliaeae	*Nanas*	–	H	FF, Dr, Or	3
Andrographis paniculata Nees.	Acanthaceae	*Sambiloto/Daun Holand*	–	H	Me	1
Arachis hypogaea L.	Fabaceae	*Kacang tanah*	–	H	Ve	1
Arcangelisia flava Merr.	Menispermaceae	*Tali kuning*	*Ayaa Kuni*	L	Ro, Me	2
Brassica oleracea L. *var. capitata* L.	Brassicaceae	*Kol*	–	H	Ve	1
Brassica rugosa (Roxb) L.	Brassicaceae	*Sawi*	*Sasawi*	H	Ve	1
Capsicum annuum Linn.	Solanaceae	*Cili panjang*	*manisa*	S	Co	1
		Cili besar	*manisa*			
Capsicum frutescens Linn.	Solanaceae	*Cili kecil*	*manisa*			
Cassytha filiformis Linn.	Lauraceae	*Tali putri*	*Ayaan putri*	L	FF, Me	2
Chromolaena odorata (L.) R.M.King & H.Robinson	Asteraceae	*Sunga sunga*	–	H	Me	1

Continued to next page

Appendix 5... Continued

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Clerodendrum fragrans (Vent.) Willd.	Verbenaceae	*Daun pata*	–	H	Me	1
Clerodendrum villosum Blume	Verbenaceae	*Picahpiring*	–	S	Me	1
Colocasia esculenta (L.) Schott	Araceae	*Talas*	*Keladi*	H	SF, FF, Or	3
Commelina benghalensis Forst.	Commelinaceae	*Sambung tulang*	–	H	Me	1
Costus speciosus (Koenig) Smith	Zingiberaceae	*Lampuyang*	–	H	Co, Cos	2
Crinum asaticum Blanco	Amaryllidaceae	*Bawang laut*	–	H	Or	1
Cucumis sativus L.	Cucurbitaceae	*Ketimun/Katimun*	*Papinyu*	H	FF, Ve, Dr	3
Cucurbita moschata Duchesne ex Poir.	Cucurbitaceae	*Labu*	–	H	SF, Ve	2
Curcuma domestica Valeton	Zingiberaceae	*Kunyit hutan/ Kuning hutan/ Kuning pawar*	*Kapali*	H	Co, Me, Cos	3
		Kunyit/Kuning (ditanam)	*Kuni*			
Cymbopogon citratus Stapf.	Poaceae	*Sare banda*	–	H	Cos	1
Cymbopogon nardus Rendle	Poaceae	*Sare*	–	H	Co, Cos	2
Cyperus kyllingia Endl.	Cyperaceae	–	*Ai Hua gonggong*	H	Cos	1
Derris elliptica Benth.	Fabaceae	*Tali Bori*	*Ayaan minu*	L	FT, Ro, Me	3
Desmodium umbellatum DC.	Fabaceae	*Daun bedak*	–	H	Cos	1
Diplazium esculentum (Retzius) Swartz	Athyriaceae	*Paku Paku/Pakis*	–	H	Ve, Or	2
Etlingera elatior (Jack) R.M. Smith.	Zingiberaceae	*Galoba*	*Manipa*	H	Co	1
Euphorbia prunifolia	Euphorbiaceae	*Daun Kastarole/Salamake*	–	H	Me	1
Hiptage sp.	Malpighiaceae	*Tali Papua*	–	L	Ro	1
Imperata cylindrica (L.) Beauv.	Poaceae	*Alang alang / Kusu Kusu*	*Enin tamun*	H	Me	1
Ipomoea aquatica Forsk.	Convolvulaceae	*Kangkung maraya*	–	H	Ve	1
Ipomoea batatas Poir.	Convolvulaceae	*Patatas/Ubi Jalar*	*Uhin*	H	SF, FF, Ve	3
Ipomoea pes-caprae (L.) R.Br.	Convolvulaceae	*Katang Katang*	–	H	Me	1
Kaempferia galanga Linn.	Zingiberaceae	*Cangkor*	*Kasu Ku*	H	Co, Me	2
Luffa acutangula (L.) Roxb.	Cucurbitaceae	*Patola/Gambas*	–	L	Ve	1
Lycopersicon esculentum	Solanaceae	*Tomat*	*Tamati*	H	FF, Ve, Co, Dr, Cos	5
Merremia peltata Merr.	Convolvulaceae	*Tali Hulali/Hulale*	*Hulanin aan*	L	Ro	1
Momordica charantia L.	Cucurbitaceae	*Papari/Pare*	*Kaparia*	H/L	Ve, Me	2

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Nasturtium indicum DC.	Cruciferaceae		*Ai toto kapi kapi/Ai totun makapi*	H	Cos	1
Nomaphila stricta (Vahl.) Nees.	Acanthaceae	*Akar burung*	–	H	Me	1
Nothopanax scutellarium Merr.	Araliaceae	*Mangkok*	–	H	Cos	1
Ocimum bassilicum Linn.	Lamiaceae	*Kumangi*	–	H	Co	1
Orthosiphon aristatus Miq.	Lamiaceae	*Kumis kucing*	–	H	Me	1
Paederia verticillata Blume	Rubiaceae	*Tali konto konto*	*Ai toto otoki*	L	Ro	1
Pandanus polycephalus Lam.	Pandanaceae	*Daun tikar*	*Kihutotun*		HF	1
Pandanus sp.	Pandanaceae	*Daun Pandan*	–	H	Co, Me	2
Peperomia pellucida H.B.& K.	Piperaceae	*daun dingin*	–	H	Cos	1
Phaseolus vulgaris L.	Fabaceae	*Bonces/Bunces*	–	H	Ve	1
Phyllanthus niruri Linn.	Euphorbiaceae	*Daun cinta cinta*	*Muhu Nalan*	H	Me	1
Physalis minima Linn.	Solanaceae	*Tiplukan*	–	S	Me	1
Piper betle L.	Piperaceae	*Sirih Buah*	*Kamu matan*	L	FF, Me, Ri	3
Piper nigrum L.	Piperaceae	*Lada*	–		Co	1
Piper sp.	Piperaceae	*Sirih Lele*	*Kamu laka*	L	Me	1
Plectranthus rotundifolius (Poir.) Spreng	Lamiaceae	*Kumbili/Ubi Kumbili*	*Esi Ahu*	H	SF, FF	2
Pluchea indica (L.) Less.	Asteraceae	*Beluntas*	–	H	Me	1
Calamoideae	Arecaceae	*Rotan/Tali Rotan*	*Ulesa/Ayaan Ulesa*	L	HF, FT, Ro, Or, Ba	5
Saccharum officinarum L.	Poaceae	*Tebu*	*Tohun*	H	Su	1
Sechium edule (Jacq.) Sw.	Cucurbitaceae	*Labu siam/siang*	–	H	Ve	1
Selaginella willdenowii (Desv.) Bakh.	Selaginellaceae	*Soka Soka*	–	H	Me	1
Senna alata Roxb.	Fabaceae	*Kupang Kupang*	–	H	Me	1
Sida acuta Burm.f.	Malvaceae	*Sapu Sapu Ternate*	–	H	Me	1
Solanum melongena	Solanaceae	*Terong/ Aubergine*	*Paloli*	H	VE	1
Stachytarpheta jamaicensis Gard..	Verbenaceae	*Kakurang*	–	H	Me	1
Tecomanthe ternatensis v. Steenis	Bignoniaceae	*Tali bela empat*	*Ayaan Rina rina*	L	Ro	1
Tetracera nordtiana F.Muell.	Dilleniaceae	*Tali api*	–	L	Ro	1
Tetrastigma papilosum (Blume) Planch.	Vitaceae	*Tali Saku*	*Ayaa Solun*	L	Ro	1
Tinospora crispa Diels.	Menispermaceae	*Antawali*	*Tali gurita*	L	Me	1

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Appendix 5... Continued

Genus species	Family	Vernacular name in Indonesian	Vernacular name in Bahasa Saleman	GF	UC	NU
Vanilla mexicana Mill.	Orchidaceae	*Vanili*	–	L	CC	1
Vigna radiata (L.) Wilezek	Fabaceae	*Kacang hijau/Kacang tumbuh*	–	H	Ve	1
Vigna unguiculata (L.) Walp	Fabaceae	*Kacang panjang*		H	Ve	1
Zea mays L.	Poaceae	*Jagung*	*Alamahu*	H	SF, FF, Ve, Cos	4
Zingiber officinale Roscoe	Zingiberaceae	*Halia/Jahe*	*Sohi*	H	Co, Me	2
Zingiber sp.	Zingiberaceae	*Tumbuh lawan*	–	H	Cos	1
Anredera cordifolia (Ten.) van Steenis	Basellaceae	*Penahong*		L	Me	1
Bambusoideae	Poaceae	*Bambu*	*Tipau/Luleba*	H	HF, FT, Ro, Ve, Or, Ba	6

Legend
GF: growth form; T: tree; H: herbaceous; L: liana; S: shrub;
UC: use categories; NU: number of uses
Uses: CC: cash crops, SCC: supplementary cash crops, HS: housing construction, CaC: canoe construction, FW: fuelwood, HF: household furniture, FT: fishing tool, Ro: Rope, SF: staple food, FF: fruit for food, Ve: vegetable, Co: condiment, Dr: drink, Su: sugar, Oi: oil, Me: medicine, Cos: cosmetic, Or: ornamental, Fe: fence, Fer: fertilizer, Pt: protection tree, Ba: basketry, Ri: ritual, Oth: Other.

Appendix 6. Selling prices and estimation of one year production of the main cash crops (production/year/garden).

Production	Number of harvests per year	Yield per harvest (kg) (min)	Yield per harvest (kg) (max)	Yield per year (kg) (min)	Yield per year (kg) (max)	Sale price per kg	Cash income per year (min) IDR	Cash income per year (max) IDR	Cash income per year (max) EUR	Cash income per year (max) EUR
Clove	1	120	300	120	300	150,000	18,000,000	45,000,000	1500	3750
Nutmeg	2	24	70	48	140	75,000	3,600,000	10,500,000	300	875
Nutmeg "flower" (mace)		7	20	14	40	140,000	1,960,000	5,600,000	163	467
Cocoa	4	45	75	180	300	16,000	2,880,000	4,800,000	240	400

Note: IDR: Indonesia rupiah; EUR: Euros

Complex agroforestry systems, which are tree-based systems with high species diversity and a complex structure similar to that of natural forests, are widespread in Indonesia. Most are mixed tree plantations managed by smallholders. They make a substantial contribution to rural livelihoods as a source of cash income and subsistence products. In this study, we investigated the characteristics of mixed tree gardens in the north of Seram Island, Maluku, Indonesia, and assessed their importance for the local community. We conducted participatory mapping and structured interviews to understand the articulation of mixed tree gardens with other land uses and to identify local farming practices. Twenty-two gardens were visited, in which 25 plots (each 20 m × 20 m) totaling 1 ha of gardens were established, and their structure and floristic composition characterized. Finally, free listing exercises and structured interviews were conducted to identify useful plant species. Five types of gardens characterized by a forest-like structure and a considerable number of wild tree species were identified. We inventoried 227 useful species and 23 different uses of plants.

Establishing such agroforestry systems in a buffer zone that limits further access to the neighboring Manusela National Park may resolve conflicts between local communities and park authorities.

This research was carried out as part of the European Union funded Collaborative Land Use Planning and Sustainable Institutional Arrangement project (CoLUPSIA). Run by CIRAD in partnership with CIFOR, TELAPAK and several local NGOs and Universities, the project aims to contribute to avoided environmental degradation and to strengthen land tenure and community right by collaboratively integrating all stakeholders' views in land use planning processes. The outputs revolve around the relationship between land use planning, land allocation and the provision and potential payment of ecosystem services. The project focuses on two regencies (kabupaten), Kapuas Hulu and Central Maluku in Indonesia.

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