Chapter 2

Literature Review

2.1 Homegarden definitions

The term ‘homegarden’ is used to describe a variety of land use systems from vegetable planting around the house to complex multi-storeyed systems (Fernandes and Nair 1986). There are many definitions of ‘homegarden’ from many researchers across the world. Some of them are:

> *Homegardens are land use practices involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and, invariably, livestock, within the compounds of individual houses, the whole crop-tree-animal unit being intensively managed by family labor* (Fernandes and Nair 1986).

> *Homegardens are a system for the production of subsistence crops for the gardener and his family. It may or may not have the additional role of production of cash crops. It can be immediately surrounding the home or slightly further away, but still near the residential area* (Soemarwoto 1987).

> *Homegardens are open spaces surrounding houses privately owned* (Arifin et al. 1998).

> *Homegardens are a multi-story, multi-species, multi-use small-scale land-use system in particular ecosystems that are for the immediate needs of household members primarily as regards their food, health, fuel and spiritual requirements* (Bennett-Lartey et al. 2002).

Homegardens are small gardens adjacent to most farmers' living quarters (Vogl and Vogl 2003).

Homegardens are intimate, multi-story combinations of various trees and crops, sometimes in association with domestic animals, around homesteads (Kumar and Nair 2004).

Homegardens are predominantly fenced-in gardens, surrounding individual houses, planted with fruits and other trees, vegetable herbs and annual crops (Wiersum 2004).

Homegardens are a traditional agroforestry systems characterized by the complexity of their structure and multiple functions (Das and Das 2005).

Homegardens are defined as a system of production of diverse crop plant species, which can be adjacent to household or slightly further away and is easily accessible (Sunwar et al. 2006).

Homegardens are a mixture of deliberately planted vegetation, usually with a complex structure and designed to produce natural products for the household or market (Kabir and Webb 2009).

Homegardens are a traditional agroforestry system which is cultivated with a mixture of annuals, perennials and trees, and is a common feature in the majority of tropical countries (Gao et al. 2012).

Homegardens are traditional agroforestry system where a clearly bounded piece of land immediately surrounding the dwelling house is cultivated with a mixture of perennials and annuals, usually in association with livestock (Eroğlu 2013).

From these definitions, it could be said that a homegarden is composed of two integrals: physical component and functions. The common physical components of a homegarden include dwellings, land, and plants. Some definitions also mention animals (Fernandes and Nair 1986; Kumar and Nair 2004) and fences (Wiersum 2004). These properties are privately owned by a family. A homegarden can be part of a homestead

or located at a disjointed area, but never far from the house. The vegetables around a house, according to some definitions, could be a homegarden. However, some definitions suggest that a homegarden should be composed of many species and types of plants forming the complex system (Bennett-Lartey et al. 2002; Das and Das 2005; Kumar and Nair 2004). Despite a large number of species and individuals, these plants are deliberately managed by the gardener(s) and their family members.

The limitation of a physical definition of homegardens is that it cannot distinguish 'homegarden' from other 'home gardens' that include the orchard, ornamental, and other garden types. Therefore, many definitions also include a functional part in the definition (Bennett-Lartey et al. 2002; Das and Das 2005; Kabir and Webb 2009; Soemarwoto 1987). To be a homegarden, the garden should be primarily used for the subsistence of the owner(s) and his/her family. The main function of homegardens is food production for household consumption, of which the surplus could be sold for supplementary income. The other plants could be used to fulfill health, fuel, and spiritual requirements (Bennett-Lartey et al. 2002).

From these definitions, it can be concluded that a homegarden, in term of physical characters, is private land around or near a private house with many plant species, which are managed by its owner. These plants, according to their functional character, are used mostly for self-consumption but they also fulfill other needs of the owners. The surplus from the consumption could be sold for the supplementary income.

2.2 Plant diversity in homegardens

Diversity is the main factor maintaining the functions of homegardens. High diversity is one of the most common and prominent features of homegardens around the world (*e.g.* Fernandes and Nair 1986; Kumar and Nair 2004; Peyre et al. 2006; Sunwar et al. 2006; Tiyakoat et al. 2010). Diversity in homegardens is generally maximized in order to enhance food and nutrient diversity. By maintaining diversity in homegardens, the homegardeners would receive products, income (Trinh et al. 2003), and supplement carbohydrates, vitamins, and minerals (Abdoellah et al. 2006) all year round. Compared to other agroecosystems, homegardens have the highest diversity (Swift and Anderson 1994). Although tree richness in homegardens is lower than in the primary forest, they

have similar tree density and richness as mature forests (Scales and Marsden 2008). The diversity of homegardens in central Thailand is close to the diversity in dipterocarp forests, for example (Gajaseni and Gajaseni 1999; Lattirasuvan et al. 2010). Moreover, many studies have showed that tropical homegardens have a floristic composition that is similar to natural ecosystems (Albuquerque et al. 2005; De Clerck and Negreros-Castillo 2000; Shastri et al. 2002). In the countries in which primary forests are degraded and diminishing, widespread agroforestry system such as homegardens could potentially help to conserve plant diversity (Kabir and Webb 2008). The number of species in homegardens can be more than 100 (e.g. Kabir and Webb 2008; Mendez et al. 2001; Vogl and Vogl 2003) so they can be important repositories of plant diversity (Kabir and Webb 2008). Homegardens are an important source of diversity at the species level, but also of intra specific variation for instance of edible plant variation. In northern Vietnam, taro diversity is high, and farmers use 17 different agromorphological indicators to distinguish varieties of *Colocasia esculenta* (L.) Schott (Trinh et al. 2001).

2.3 Factor affecting homegarden characteristics and diversity

The species composition of plants that grow in homegardens is regulated by many factors. Like plants grown in forests, species found in homegardens are limited by ecological factors such as annual air temperature, elevation, *etc*. However, plants in homegardens are tended by their owners, which is an anthropological factor, so the characters of their owners and other factors affecting them would also affect homegardens characteristics. Various researches have proposed many factors which could be divided into four categories: (1) ecological factors, (2) homegarden characteristics, (3) socio-economic factors, and (4) homegardeners' characteristic factors.

2.3.1 Ecological factors

The ecological or environmental factors are any abiotic or biotic conditions that influence the species of plants grown in homegardens. This includes factors caused by the location of the homegardens such as distance from the urban center or road, or the level of isolation from other communities.

One of the conspicuous ecological factors which is often reported as important in determining diversity, richness, and species composition in homegardens is elevation. Increase of elevation result in decrease of temperature (Hodel et al. 1999; Karyono 1990) which is one of the most important growth factors. Comparing homegardens in the same region, those at lower elevation tend to have higher diversity and richness than those at higher elevation as shown in the studies in Ethiopia (Tesfaye 2005) and Indonesia (Kehlenbeck et al. 2007). Not only the species richness but also the complexity of plants structure is another homegarden characteristic which decreased in higher elevation. Homegardens at high elevations tend to have more annual vegetables and herbs, and fewer fruit trees (Castineiras et al. 2001; Shrestha et al. 2001). However, plant diversity in homegardens is not absolutely related to the elevation. A study in Venezuela showed that homegardens located at mid elevation possess highest plant diversity because both tropical and subtropical plant could be cultivated there.

Water supply is another important agro-ecological factor influencing the diversity of plants in homegardens. Precipitation and irrigation are two main sources of water supplies. Homegardens with better water supply, higher precipitation or better irrigation system, possess higher plant diversity than those with lower quality of water supplies (Bennett-Lartey et al. 2002; Blanckaert et al. 2004).

Proximity to urban centers decreases the diversity and complexity of plants in homegardens due to the increase of commercial and ornamental plants (Panyadee et al. 2012; Wezel and Ohl 2005). However, some homegardens located closer to the urban center or the market may have increased species richness because of the accessibility to new exotic species especially ornamentals (Kabir and Webb 2009). Isolation is another factor which lowers species richness in homegardens. Homegardens in isolated communities may lack opportunities to exchange plant species and knowledge with other communities (Srithi et al. 2012b; Wezel and Ohl 2005). However, as the effect of this factor may differ from place to place, it may show no effect (Milow et al. 2013) or a measurable (Kehlenbeck and Maass 2004).

2.3.2 Characteristic of homegardens

Characteristics of homegardens would influence the species, habit, species richness, and diversity of plant in homegardens. Size is one of the most important characters determining species and habit of plants grown in homegardens. Larger homegardens tend to have more plants individuals and species, especially tree species which need more space for growing (Abdoellah et al. 2002; Hodel et al. 1999; Kehlenbeck 2007; Quiroz et al. 2001). However, the small size of a homegarden may inspire its owner to accumulate more plants, resulting in higher richness in smaller homegardens (Kumar et al. 1994). In communities influenced by commercialization, the owner of big homegardens may favor cultivating commercial species which would lower the diversity in the homegarden (Peyre et al. 2006).

Accumulation through time is another important factor that increases the number of species and individuals in homegardens. So, older homegardens would have more species and individuals of plants than younger ones (Abdoellah et al. 2006; Abebe et al. 2006; Albuquerque et al. 2005; Coomes and Ban 2004; Huai et al. 2011; Kabir and Webb 2009; Lattirasuvan et al. 2010; Perrault-Archambault and Coomes 2008; Quiroz et al. 2001; Sunwar et al. 2006; Trinh et al. 2003). However, the effects of this factor may be very weak or insignificantly related to plant diversity in homegarden (Albuquerque et al. 2005; Bardhan et al. 2012; Bassullu and Tolunay 2010; Kabir and Webb 2009; Kehlenbeck et al. 2007; Kehlenbeck and Maass 2004; Perrault-Archambault and Coomes 2008; Vlkova et al. 2010).

2.3.3 Socio-economic factors

Because “man is by nature a social animal”, intentionally or unintentionally homegardens, which are created by humans, are certainly influenced by the society to which their owners belong. Among many socio-economic factors, commercialization is often mentioned in homegarden studies. Commercialization may be promoted by government policy, encouraging homegardeners to cultivate commercial plants that are preferred by market demand such as *Allium fistulosum* L., *Raphanus sativus* L., *Ipomoea batatas* (L.) Lam., *etc*. (Abdoellah et al. 2002; Vlkova et al. 2010). Comparing traditional and modern homegardens in Kerala, India, the former is smaller but with

many native species while the latter is bigger and mostly dominated by a few commercial plant species (Peyre et al. 2006). This situation is also true in homegardens in Indonesia where cocoa and coffee are promoted by the governor which resulted in the decrease of a number of plant species in homegardens (Kehlenbeck et al. 2007). The effect of commercialization is more obvious in urban communities than in rural communities (Esquivel and Hammer 1992). However, cultivation of commercial plants in homegardens permits their owners to receive more income which increased their production factors resulting in more area and more plants grown in homegardens (Hodel et al. 1999; Quiroz et al. 2001; Trinh et al. 2003).

Urbanization also changed plant composition, diversity and richness, and functions in homegardens. Ornamental and commercial plants in homegarden near to the urban center significantly increase both numbers of species and individuals (Kehlenbeck et al. 2007). Moreover, the areas of homegardens in the urban area would be reduced due to the competition with other facilities.

Households' dependency on homegardens also increase both the number of individuals and species cultivated in homegardens. The dependency was inversely related to household income from agriculture and off-farm activities (Kumar and Nair 2004). However, if the owners lack the land for cultivating staple food crops, they have to reserve part of the homegarden to cultivate staple food crops. This will lead to lower plant diversity in homegardens (Soemarwoto and Conway 1992).

2.3.4 Gardeners' characteristics

Growing a plant species in a homegardens means losing a space for growing another species and labor is needed to take care of this new species. Homegardeners evaluate the plants in their homegardens and make decisions to keep or discard such species. So the gardeners are another important factor who determines which plants are grown in homegardens to fulfill the owner's needs (Gajaseni and Gajaseni 1999; Kumar and Nair 2004; Mendez et al. 2001). Older homegardeners tend to have homegardens with more diversity of plants than younger homegardeners. One of the reasons is the accumulation through time which is related to the age of homegardens as mentioned above or because old homegardeners have more laborers in their families than young

gardeners have (Quiroz et al. 2001; Tesfaye 2005). Background career of the homegardeners also influence plant diversity in homegardens. Homegardeners who have agricultural background are more experienced and more familiar with cultivating plants. These homegardeners seem to have more plant species and diversity in their homegardens than homegardeners with different backgrounds (Kehlenbeck et al. 2007).

Gender and status of the family head also influence the characters of homegardens. Most plants in a homegardens of single male heads are edible species while single female head allocate most of the area in their homegardens for medicinal and ornamental plants. Married heads' homegardens have about equal numbers of these plant groups (Christine 2009).

Different ethnic groups need different plant products, especially vegetables and herbs (Shrestha et al. 2001; Soemarwoto and Conway 1992; Trinh et al. 2003) leading to the difference of species found in different ethnic groups' homegardens. Homegardens of immigrants tend to have higher species richness than homegardens of indigenous people because of the combination of imported and native species (Kehlenbeck et al. 2007). However, the immigrants may lack the land to do homegardening and have to focus on staple and commercial species. In this case, the homegardens of the immigrants may have less plant diversity than those of indigenous people (Hodel et al. 1999).

2.4 Homegarden studies in Thailand

Homegardens are important for preserving ethnobotanical knowledge of communities in Thailand. For this reason, they are always mentioned in ethnobotanical studies, directly or indirectly (see below). Despite this importance, only few studies focus directly on homegardens. The first homegarden study in Thailand was conducted in 1987 by Ambar and others at a community in Khon Kaen province, north-eastern Thailand (Rambo 1991). This study described the characteristics of homegardens at the study site. The average size was about 1000 m^2, and the average number of species per homegarden varied from 18–49. Moreno-Black and collaborators (1996) conducted

another investigation in north-eastern Thailand and found 230 plant species from homegardens composed of domesticated plants, exotic species, and local non-domesticated plants. Most of these plants were edible plants. They also found that homegardens were mainly managed by women, and concluded that the main function of homegardens was food production.

Homegardens are dynamic systems that vary over time. Miyagawa and Konchan (1990) studied the seasonal variation of crops in homegardens in Khon Kaen province and concluded that the variations were caused by ecological traits of the crops, climatic conditions, and the rice cropping calendar. Moreover, they found that among 156 useful plants, chili (*Capsicum annuum* L.) was the most dominant crop which occupied most of the garden area in all seasons. Cruz-García and Struik (2015) also showed that diversity, abundance, and frequency of wild food plants in homegardens in Kalasin province differed in different seasons. Homegardens had more wild plant species diversity in the dry season than in the rainy season because of human management.

A comparative study of homegardens and other agroforestry systems in the highlands of northern Thailand showed that homegardens could sustainably generate income with low cost (Preechapanya 1993). Generally, homegardens in the highlands were placed on the lower slopes, compared to other agroforestry systems, near the dwellings. Plants were intensively cultivated and forest species, including fruit trees, herbs, and vegetables, were also grown freely in homegardens for household consumption (Preechapanya 1993). Moreover, plants in homegardens were more diverse and differed from other nearby agroforestry systems (Withrow-Robinson and Hibbs 2005). The study of ecological characteristics of homegardens in Phrae province revealed that the diversity indices in these homegardens were higher than in mixed deciduous forest and teak plantation in northern Thailand. Most plants found in this study were food plants, which conforms to others studies from the tropics. Comparing to other land use systems in northern Thailand, soils in homegardens have higher nutrients (Lattirasuvan et al. 2010).

Ethnic groups are social groups that share a common cultural tradition (www.oxforddictionaries.com). Northern Thailand is the home of various ethnicities. Each ethnic group possesses particular ethnobotanical knowledge, a part which is

represented in their homegardens especially by the cultural identity plants (Trinh et al. 2003). A comparative study between Hmong and Mien homegardens in Nan province by Srithi et al. (2012b) revealed that besides the homegardens' geographical location, cultural background was another important factor affecting the homegardens' compositions. Homegardens are an important place for conserving ethnic cultural identity. Moreover, they also found that homegardens are reservoirs of plant diversity; they found more than 400 species in 180 studied homegardens. Homegardens of ethnic groups are very important for conserving native crops and vegetables. The investigation in Shan homegardens, Mae Hong Son province, showed that there were 127 species of edible species found in 127 studied homegardens (Panyadee et al. 2012). Moreover, Panyadee et al. (2012) showed that the distance from urban centers had negative effects on the richness of plants found in Shan homegarden, and that was true especially for medicinal species.

A study in Chao Phraya Basin in central Thailand showed that the biodiversity of homegardens was similar to that of a dipterocarp forest (Gajaseni and Gajaseni 1999). Moreover they also found that the main factor that regulated species cultivated in homegardens was the use of the products derived from their plants. The high diversity of plants in homegardens is also demonstrated in a study in Nonthaburi province by Sampanpanish and Jamroenprucksa (1994). They found a total of 58 tree species, most of which were fruit trees. The Shannon index was 4.0 which is close to that of the mixed deciduous and dry evergreen forests.

2.5 The benefit of homegardens

Homegardens are commonly found as part of homesteads in many countries, especially in tropical and subtropical regions (Kumar and Nair 2004). The reason behind this commonness is their role in providing daily needs for their owners. This role of homegardens could be found in both rural and urban areas (Kortright and Wakefield 2011).

Normally, there are many species, life forms, and functions of plants in homegardens. These plants could be cultivated or self-grown species but certainly provide some benefits to their owners. Many researches have revealed the benefits of the homegardens including direct benefits to their owners and indirect benefits to their surrounding environments, such as rare species conservation and benefits to the communities.

2.5.1 Direct benefits of homegardens

Caloric and nutritional supplies are the most obvious and significant benefits from homegardens to their owners. Homegarden studies have often found that most species are edible including herbs and fruit trees. Comparative studies of homegardens from eight cultural groups in southwest China showed that food production for self-consumption is the main function of the gardens. They found that food plants contributed up to 45% of all species in 124 studied homegardens (Huai et al. 2001). Mendez et al. (2001) studied homegardens in Nicaragua and reported that fruit trees are found in all studied homegardens and most products from these trees were consumed by their owners. An Amazonian homegarden study revealed that in homegardens, the primary plants were fruit species. This category contributed 44% of the species in this study. Similarly, a homegarden study in Vietnam showed that the major component of homegardens is that of edible plants which provide food that provide the daily diet for their owners (Vlkova et al. 2010). So the homegarden owners can obtain a number of nourishing and convenient products from their homegardens (Kortright and Wakefield 2011).

Besides providing food supplies, homegardens are an important source of complementary income for their owners, especially in rural areas (Kehlenbeck et al. 2007). This income is derived mostly from selling surplus products at local markets. The income could come from both animals, like pig, poultry, or fish, and plants (Arifin et al. 2012). Homegardens could be adapted for household food security or income generation depending on the needs of the family (Trinh et al. 2003). For example, for the household with HIV/AIDs-afflicted head, homegardens are important source of income so these families would invest more labor and capital in their homegardens comparing to non-HIV/AIDs-afflicted head families (Akrofi et al.

2008). Arifin et al. (2012) showed that the products from plants in Java homegardens contributed an average of 2% of the total household income. In Jinping County, China, rubber trees, which are grown only for income generation are also found in homegardens (Huai et al. 2011). Homegardens can also be a main source of income, as in Nicaragua (Mendez et al. 2001). They also found that homegardens are the most frequently cited source of income. In mountainous environment where common cash crops such as fruits and rice are not common, the income derived from homegardens is very important for the household. Trinh et al. (2003) reported that in Nghia Dan, a community in mountainous area, income from homegardens contributed 22% of the total income, although most products from homegardens were used for self-subsistence. The diversity of crops cultivated in homegardens can provide income year-round. From this reason homegardens, beside self-sustenance, is a very important source of income for many families (Trinh et al. 2003). Not only generating direct money to the gardeners, homegardens also increased the income by reducing the food expense (Arifin et al. 2014).

Medicinal plant is another plant category that is commonly found in homegardens. The purpose of planting medicinal plants in homegardens could be using them for healing household members or selling to the local herbal markets. A study in northwestern Yunnan, China revealed that about 90% of medicinal plants grown in homegardens were sold in the herbal markets (Yang et al. 2014). Moreover, it should be noted that although many studies have shown the negative effect of commercial plants on plant diversity in homegardens, income generation may promote plant diversity in homegardens. The researchers found that the highest plant diversity is found in homegardens that are managed both for self-consumption and income generation (Mendez et al. 2001; Trinh et al. 2003).

Additionally, benefits of homegardens to the gardeners include providing a place for experimenting with new crops or new cultivation method (Akinnifesi et al. 2010; Kumar and Nair 2004; Kujawska and Pardo-de-Santayana 2015), animal breeding (Bassullu and Tolunay 2010), source of materials (Huyin et al. 2011), and space for other agricultural work such as drying agricultural products (Bussmann et al. 2008).

2.5.2 Indirect benefits

Many plants found in homegardens are transplanted from other habitats, especially from the nearby forests. Intentionally or un-intentionally homegardens could be a safehaven for endangered species. Besides plant species, homegardens are also a habitat for endangered wild or semi-domesticated animals (Akinnifesi et al. 2010). Many species that are threatened in nature because of over exploitation and habitat destruction can commonly be found in homegardens, e.g. *Caesalpinia echinata* Lam. (Akinnifesi et al. 2010), *Aquilaria malaccensis* Lam. and *Eurycoma longifolia* Jack (Milow et al. 2013). So homegardens are the repositories for endangered and over-collected species especially medicinal ones (Huai et al. 2011).

Many plant species in the threatened categories in IUCN's red lists have been reported in homegardens. Kabir and Webb (2008) reported that six species of plants found in Bangladesh are on the IUCN Red List. Some species that are threatened in nature but are favored by local people especially those commonly used in daily life would be cultivated in homegardens for the convenience of use. For example, *Elsholtzia penduliflora*, a threaten species in Thailand, is commonly grown in Hmong homegardens. The leaves of this species are used as a main ingredient of chicken soup (Nguanchoo et al. 2014).

Besides conserving threatened species, homegardens are also important for harboring native species especially emergent trees (Albuquerque et al. 2005). However, it should be noted that most gardeners are not aware of the status and rarity of the species found in their homegardens. To promote this role of homegardens, there should be some efforts from the government or NGOs to encourage the awareness and the knowledge of the homegardeners in this respect.

Edible plants grown in homegardens provide food security not only for individuals and families but also for communities by benefiting community members to easier access a safe, nutritious, and cultural diet (Kortright and Wakefield 2011). Moreover, plants in homegardens contribute to carbon sequestration and mitigate effects of climate change (Balooni et al. 2014).

2.6 Ethnobotany and homegardens in Thailand

Ethnobotany is the study of the mutual relationships between traditional people and plants (Cotton 1996). In this sense, all plants surrounding us should be our focus. However, most ethnobotanical studies concentrate on plants that grow in the forest surrounding the communities. Plants in homegardens include cultivated and self-grown species which are used by the owners. Homegardens are important for ethnobotanical knowledge. Ethnobotanical studies of Akha and Thai Yuan who live in northern Thailand have shown that homegardens are commonly found in their homestead as a place where they plant and harvest many species that they use for their daily life (Inta 2008; Inta et al. 2013).

Homegardens are always mentioned as one of the ethnobotanical habitats, but the data has usually been mostly gathered in nearby forests. Homegardens may be directly mentioned in the Material and Methods sections (e.g. Khamfachuea et al. 2010; Nguanchoo et al. 2014; Srithi et al. 2012a; Tangjitman et al. 2015; Trisonthi and Trisonthi 2011) or indirectly (e.g. Chamratpan 2005). Homegarden plants comprise a variety of life from, origins, and use categories although food and medicine are the most common uses.

Food plants (including food additive species) are a major part of homegardens, not only in Thailand but throughout the tropics. Many edible species reported in ethnobotanical investigations are found in homegardens of the studied sites. For example, the Karen people plant many vegetables in their homegardens for daily consumptions (Trisonthi and Trisonthi 2009b). These plants include both cultivated and wild species which have been transplanted from the forest. Moreover, Karen children's popular dessert fruit like mulberry (*Morus alba* L.) are only found in the homegardens (Trisonthi and Trisonthi 2009b). Cruz-García and Price (2015) reported that homegardens are the preferred place for collecting food plants. Moreover, compared to other habitats, they also found that all studied households always gathered food plants from their homegardens (Cruz-Garcia and Struik 2015). Additionally, while the number of plants gathered from forests and crop fields are seasonal, homegardens tend to provide a constant supply that can be collected all year round (Cruz-Garcia and Struik 2015).

Medicinal plants are another important plant category that is always found in homegardens of ethnic people in Thailand. Akha healers keep their important medicinal species in their homegardens for the convenience of their usage (Inta et al. 2008). Many medicinal plants in Zingiberaceae used by Karen people are mainly found in their homegardens (Tangjitman et al. 2015). Moreover, medicinal materials supplied to the Kabchoen Hospital; Surin Province, come from homegardens of people who live around the hospital.

To conserve ethnobotanical knowledge, one important strategy is to conserve local species especially in the places where the knowledge is found, which is an example of *in situ* conservation. The data from many ethnobotanical studies demonstrated that homegardens have played an important role for native species' *in situ* conservation. Many wild species in homegardens are transplanted from other areas including the forest (Cruz-Garcia and Price 2011). For the convenience of daily healing ailments, Thai Akha, Thai Yuan, and traditional healers in Phatthalung transplanted many wild medicinal species to their homegardens (Inta et al. 2008; Inta et al. 2013; Maneenoon et al. 2015). Two Hmong ethnobotanical studies showed that homegardens have conserved threatened species like *Elsholtzia penduliflora* (Nguanchoo et al. 2014), and culturally important species like *Gynura bicolor* and *Artemisa lactiflora* (Nuammee et al. 2012).

2.7 Studied ethnic groups

2.7.1 Hmong

The Hmong are one of the mountain groups that traditionally lived mostly in China, Vietnam, Laos, and Thailand. The origin of Hmong is in the southern regions of China which are now called Sichuan, Guizhou, Guangxi, and Yunnan provinces (Siriphon, 2006). The Hmong have gradually migrated to the south since the 18th century. The main causes of the migrations are the political conflicts with Han people and the Hmong's search for arable land (Siriphon 2006).

The language of the Hmong belongs to the Hmong-Mien language group of the Hmong-Mien family. Hmong use Roman alphabets invented by French-American missionary-linguists for their writing system (Bliatout et al. 1998). Previously legends, traditional knowledge, and histories were transferred only through oral transmission (Pake 1987). Hmong people include two groups with different traditional costumes; the green Hmong and the white Hmong. Although there are some differences in pronunciation and vocabulary, these two groups can understand each other's dialects of the Hmong language.

Hmong society is patrilineal; the family membership is traced through and derives from the father's lineage. Normally the head of the family who is responsible for family affairs is the oldest man (Eliot and Bickersteth 2003). One of the basic social units is the clan and in a marriage the bride and groom should come from different clans. Hmong families are usually composed of three or more generations. Polygyny, a man with multiple concurrent wives, is accepted among the Hmong and is admired as a sign of wealth and status. The Hmong believe that men are more important than women because men create a basic structure for their society and, moreover, it is only the men who can preserve the lineage (Symonds 2004).

Nowadays, the total population of Hmong is 4–5 million and most of them live in China, Vietnam, and Laos (Lemoine 2005). The number of Hmong in Thailand was about 150,000 at the latest count and they are the second largest ethnic minority in Thailand after the Karen. The Hmong may have reached Thailand around 1880 (Michaud 1997). The history of the Hmong migration to Thailand started during the Vietnam War. Many Hmong had joined the military of the Royal Lao Government supported by American troops. However, when the Royal Lao Government fell in 1973 due to the withdrawal of U.S. troops, those who had joined the army fled to many countries, including Thailand which received over 100,000 Laotian Hmong refugees (Pake 1987). Nowadays the Hmong prefer to establish their villages in the highlands, mostly, in Nan, Chaing Rai, Phayao, Chiang Mai, Phrae, Tak, Mae Hong Son, Lampang, Pitsanulok, Phetchabun, and Loei provinces.

2.7.2 Karen

The Karen are a large ethnic group living in various parts of Southeast Asia (Khin 1996a). The Karen population is about nine millions of which seven millions live in Myanmar and one million live in Thailand. The Karen is the largest of the ethnic groups living in Thailand and they make up 51% of the overall hill tribe population in Thailand. The Karen have lived in southern and eastern Myanmar since the 17th century and reached Thailand about the end of 18th century (Schmidt-Vogt 1999) across the Salween River (Lewis and Lewis 1984).

Karen language belongs to the Sino-Tibeto family (Paul 2009). There are many dialects in Karen language, the two main ones being Pwo and Sgaw. The Sgaw use Mon script for their writing while the Pwo use a script developed by Baptist missionaries (Gilmore 1898). In Thailand the four largest Karen groups are the Sgaw, Pwo, Bwe, and Pa-O.

The Sgaw, who call themselves Pwa Kar Nyaw, are the largest group. They can be found in all Karen ranges. There are about 500,000 Sgaw in Thailand, mostly in Tak, Mae Hong Son, Chiang Mai, Kanchanaburi, and Ratchaburi provinces (Lewis and Lewis 1984).

The Pwo, who call themselves Ploe, are the second largest group. In Myanmar, Pwo live only in lowland areas but in Thailand most live in mountain villages (Princess Maha Chakri Sirindhorn Anthropology Centre 2000). The Pwo population in Thailand is about 80,000 and they live mostly in Tak and Chiang Mai provinces (Lewis and Lewis 1984).

The Bwe, who call themselves Bway, live mostly in Toungoo District in northern Karen State. In Thailand, they are called red Karen because the married women prefer dressing in a red shirt and a sarong. About 1500 Bwe live in Thailand in Mae Hong Son province.

The Pa-O, who are called Tuangthu by Shan and the Burmese, is the smallest group of Karen in Thailand. The population is about 600 in Mae Hong Son province. This group is sometimes not recognized as belonging to the Karen group by many

anthropologists (Princess Maha Chakri Sirindhorn Anthropology Centre 2000). Most Pa-O live in Shan State in northern Myanmar. Pa-O women prefer dressing in a black shirt with a white or black turban.

The Karen traditional house is simple, constructed with stilts and split bamboo for walls and floor. The roof is usually made of thatch of the grass *Imperata cylindrica* (L.) Raeusch. or the palm *Livistona speciosa* Kurz. Cattle are kept in a separated pen while chicken and pigs are left to roam freely around their homestead.

Most ethnobotanical research in Thailand focus only on the Sgaw who, in Thailand, live in great harmony with the forest (Khin 1996a) and they still rely on forest product for their daily life, especially for food and medicine (Trisonthi and Trisonthi 2009a). In this study, we focus only on the Sgaw.

2.7.3 Lahu

Most of the Lahu live in Yunnan province, China, near the Myanmar border (Khin 1996). Beyond China, they live scattered through the Shan State (Myanmar), northern Thailand, Nam Tha province in Laos, and northwestern Vietnam (Khin 1996b). The origin of Lahu is in the Qinghai-Tibetan plateau. They migrated south and settled around Dali during the 3rd–5th century. About the 10th century, the Lahu started a huge migration to the south. Because of a conflict with the Chinese dynasty the Lahu moved south and established in Shan State by the 1830s and in Laos by 1850s. They may have reached northern Thailand in the 1870s or 1880s.

The language of Lahu belong to Sino-Tibetan language family, and it is related to the Lisu and Karen languages. The Lahu do not have their own writing system. They once used chicken feathers with notched sticks attached to communicate simple message (Matisoff 1991). Nowadays, the Thai, Chinese, and missionaries developed the script based on Thai, Chinese, and Roman script for a Lahu writing system. There is a lore stating that in ancient time, the Lahu had their own script written on rice cakes, invented by ancient scholars. However, when these scholars were hungry and ate the cakes, the script disappeared. Every year, at the Lahu New Year ceremony, they eat rice-sesame cakes to remind themselves of the loss of their wisdom.

The total population of Lahu is about one million and they are divided into many subgroups. About 700,000 live in the western Yunnan Province in China in the mountains around the Mekong River. There are an estimated 100,000 Lahu in Thailand mostly in Chiang Mai, Chiang Rai, and Mae Hong Son provinces.

There are two groups of Lahu in Thailand; the Black Lahu and the Yellow Lahu. The former is the main group, forming 75 percent of the Thai Lahu and they are divided into three subgroups; Lahu Nyi or the Red Lahu, Lahu Na or the Black Lahu, and Shehleh Lahu. The Yellow Lahu in Thailand is Lahu Shi which is the smallest groups of Lahu in Thailand.

The traditional houses of the Lahu are usually made of bamboo, with a grass thatching. The houses are raised on wooden piles about 1–1.5 meter above the ground. There are two sections in the house. The terrace is the common area and the men's area for all family members and guests. The second area is private and for the women. There is a stove for cooking food and boiling water in the middle of the house (Oranratmanee 2009).

2.7.4 Lawa

The Lawa live only in northern Thailand (www.a.northernthailand.com) with a population of approximately 17,000 in the provinces of Mae Hong Son and Chiang Mai. They are believed to be one of the first settlers in this region of Thailand, having arrived sometimes around the 5th century BC (www.a.northernthailand.com). The exact origin of the Lawa is still debated. Some archeologist believe that they migrated from Cambodia, but some say they originated in Thailand (Young 1962). The Lawa are sometimes called Lua by Thai people, which has led to mistaking them for being the same ethnic group as Lau of northern Laos and of Nan province.

The Lawa language belongs to the Austro-Asiatic family. There are two Lawa languages spoken in Thailand: Western Lawa and Eastern Lawa. Eastern Lawa was spoken in Hot district, Chiang Mai province while the western Lawa was spoken in the mountains of Mae Hong Son and Chiang Mai provinces. The Lawa use Thai script for writing. The system was developed by Christian missionaries, first using a Roman

script. To ease the transfer between Thai and Lawa education, they changed the script to Thai characters . The script is used for religious textbooks, letters, poetry, and songs.

Traditionally, Lawa villages are located in the mountains, and they comprise 20–100 households. The village is surrounded by the conserved forest as the buffer zone between village and arable lands. The Lawa traditional house is similar to the Karen house, built on stilts and with split bamboo for walls and floor. The gable is decorated with the crossed wood called 'Galare'. This part might be beautifully carved (Oranratmanee 2013).

2.7.5 Lisu

Most members of the Lisu ethnic minority lived in Burma (Myanmar), southwest China, Thailand, and the Indian state of Arunachal Pradesh. The ancestors of the Lisu lived in northwestern China about five thousand years ago (Huang et al. 2004). Then they gradually moved to northwestern Yunnan. Subsequently, in the mid-19th century, the Lisu moved south to Burma and reached northern Thailand in the late 19th century.

The Lisu language is of the Tibeto-Burman language group of the Sino-Tibetan family. It has three main dialect groups: southern, central, and northern. In Thailand, only the southern dialect is spoken which is also true for the Myanmar Lisu living along Mogok and in different parts of Shan State. The Lisu of China, Burma, and Thailand use Fraser script, sometimes call Bible script, for writing (Lewis and Lewis 2002). This script was developed by two missionary Jame O. Fraser and Sara Ba Thaw. It adopts upper case roman letters, upright, and inverted, for consonants and vowels, and various punctuation markers for tones (Bradley 2006).

There are about a million Lisu of which nearly 600,000 inhabit southwestern China, over 300,000 inhabit northeastern Burma, and over 40,000 inhabit northern Thailand. Generally, the Lisu live in high hills, about at 1300–1700 m elevation, at the same elevation as the Hmong. In the past, the Lisu villages were not permanent because they cultivated the land using slash and burn techniques. They had to move when the soil was depleted and search for the new fertile lands, on the average every ten years.

Nowadays, according to the limitations imposed by the natural forest law, the Lisu are forced to stay permanently at the same place.

Traditional houses of the Lisu are built directly on the ground which may be a Chinese influence. Walls are made of bamboo and the roofs are thatched. The cooking fire is always lit in a box filled with earth placed in the house. The married couples' bedrooms are in the corner of the house. There is another bedroom for unmarried daughter(s) while unmarried sons sleep on the platform in the main room. Animals are raised in separate pens.

2.7.6 Thai Yuan

Yuan, who now call themselves *Khon Mueang*, are the dominant ethnic minority of northern Thailand. The origin of Yuan, according to the immigrant hypothesis, is the area which now belong to three countries: Myanmar; Laos, and Thailand. From there they moved south and conquered the native people along their route until they reached their present territory. Another hypothesis, the so-called endogenous hypothesis, states that the ancestors of Khon Muang were not the Tai from China, but the native Mon-Khmer people who were incorporated by Thai rulers. Subsequently, through an influence of Thai politics and culture, these people became Khon Muang. However, the geographic origin, biological ancestors, and demographic history of Khon Muang has not been verified with certainty due to the lack of archaeological and anthropological evidence.

The early history of Yuan relates to the area where Myanmar, Laos, and Thailand meet, which is called Yonok Chiang Saen Kingdom. The first king was Phaya Mang Rai who founded Chiang Rai in A.D. 1263. In A.D. 1281 he had conquered Haripunchai (Lamphun) Kingdom then established Chaing Mai as the new capital of Lan Na Kingdom in A.D. 1926.

Lan Na Kingdom reached the golden age in A.D. 1400 and then slowly declined after A.D. 1500. In A.D. 1558 Lan Na totally lost her sovereignty, became a tributary state of the Taungoo Dynasty, the ancient Burmese Kingdom. Later Lan Na became the frontier between Ayuthaya and the Burmese. Until A.D. 1775, the Prince Kawila of Lan

Na joined King Tak Sin to successfully overcome the Burmese and start integration to form Siam which is the present Thailand. In A.D. 1939 Lan Na was officially part of Thailand.

Nowadays, 88% of Tai people in northern Thailand speak the Yuan's language which is classified as part of Tai-Kadai family. This language is also called *Kam Mueang* with the script called *Tau Mueang* or *Tai Tham* but it is only little used today.

2.7.7 Yunnan Chinese

Yunnan Chinese or Ho is a Chinese people who originally came from Yunnan Province, China. They were known to the local people in northern Thailand for a long time from their caravans.

The migrations of Yunnan Chinese to northern Thailand are caused by many reasons such as trading, war, and following their kin to new plentiful lands (Oranratmanee 2013).

This people spoke Chinese, Southwestern Mandarin which is still used in their daily life, especially when communicating with their own kind. Nowadays, most of the population of Yunnan Chinese in Thailand live in the northern part, especially Chiang Rai, Chiang Mai, Mae Hong Son, and some of them in Lampang and Phayao province.

Traditional houses of the Yunnan Chinese are built directly on the ground. The houses were closed to each other without a clear limit. The front yard may be covered by the roof and shared with their neighbors.

2.8 Chiang Mai Province

Chiang Mai, a province in the upper northern Thailand, covers 20,107 km^2 (Department of provincial administration 2010). About 70% of its area is forest, 13% is cultivated, and the rest (about 17%) is residence area (http://gis.chiangmai.go.th/). Most of the land (80%) is mountain areas especially at the northern and western part of the province. The rest is flat plains and intermountain plateaus comprising the Ping, Phang,

and Mae Ngad basins. The major types of forests in Chiang Mai include mixed deciduous forests, evergreen forests, and dry dipterocarp forests (Tangjitman et al. 2015). There are 13 national parks located in Chiang Mai, the best known ones being Doi Inthanon, Doi Suthep-Pui, Sri Lanna, and Chiang Dao. Therefore, Chiang Mai is an important biodiversity harbor of Thailand.

The northern boundary of Chiang Mai is with the Shan State, Myanmar; the southern is with Lamphun and Tak province; to the east Chiang Mai borders Lampang, Chaing Rai, and Lamphun provinces; and to the west Mae Hong Son province. There are 25 districts, 204 sub-districts, and 2066 villages in Chiang Mai. The population in Chiang Mai was 1,686,696 in 2015. Of those, 24% were hill tribes.