

# Homegardens of the Cao Lan, a Tai-Speaking Ethnic Minority in Vietnam's Northern Mountains

Pijika Timsuksai,\* Nguyen Dinh Tien,\*\* and A. Terry Rambo\*\*\*

The Cao Lan are a Tai-speaking ethnic group living in the Midlands of Northern Vietnam. Homegardens are an important component of their agroecosystem. The ecological structures of each homegarden of 17 households of the Cao Ngoi village in Tuyen Quang province were described and modal patterns identified. Most homegardens have organically shaped planting areas with indeterminate boundaries, polycentric planting patterns, and contain multiple species within the same bed or planting area. All of the gardens have multiple vegetation levels, with the largest share having 5 levels and a majority having more than 50% of their planting area covered by overlapping vegetation layers. Biodiversity is high with a total of 113 species recorded. Most plant species are used for food, but smaller numbers have ornamental, medicinal, and construction uses or are used for animal fodder, as stimulants, or for other purposes.

Comparison of the modal structure of the Cao Lan homegardens with several Tai minority groups in Northeast Thailand, shows that, although the Cao Lan have been geographically isolated from other Tai groups for many centuries, their homegardens share a similar structural pattern, one commonly referred to as the tropical forest type. This structure is very different from the temperate type gardens of the Kinh in Vietnam with whom the Cao Lan share a common environment and are in frequent contact. The persistence of a common structural pattern among these related Tai ethnic groups, despite their inhabiting different environments, and having had no direct contact with each other for a very long time, suggests that culture exerts a strong influence over agroecosystem structure.

**Keywords:** Cao Lan ethnic minority, ethnobotany, agroecosystem structure, indigenous knowledge, biodiversity

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\* พิจิกา ทิมสุกใส, Program on System Approaches in Agriculture, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand

\*\* Nguyễn Đình Tiến, Center for Agricultural Research and Ecological Studies (CARES), Vietnam National University of Agriculture, Gia Lam, Hanoi, Vietnam

\*\*\* Program on System Approaches in Agriculture, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand; The East-West Center, Honolulu, Hawaii 96848-1601, USA  
Corresponding author's e-mail: trryrambo@yahoo.com

## Introduction

After Terra's pioneering descriptions of the different types of homegardens associated with different ethnic groups in the Indo-Malayan region (Terra 1952–53; 1954; 1958), few additional studies were published about Southeast Asian homegardens until the 1980s when homegardens emerged as a major focus of agroforestry research. Much of this research was concerned with describing the architecture, species composition, and functions of homegardens of different ethnic groups in the tropics. Since that time, a considerable number of studies have been published describing the structure, species diversity, and functions of homegardens of ethnic groups in different Southeast Asian countries, including Burma (Terra 1954), Indonesia (Soemarwoto and Soemarwoto 1984; Wiersum 2006), Laos (Kou *et al.* 1990; The SUAN Secretariat 1990; Dyg and Saleumsy 2004; Nawata *et al.* 2009), Thailand (Moreno-Black *et al.* 1996; Jiragorn and Nantana 1999; Nawata *et al.* 2009; Thanakorn *et al.* 2010; Kamonnate *et al.* 2012), and the Philippines (Snelder 2008). There has also been considerable research on homegardens in Vietnam (Le Trong Cuc *et al.* 1990; Karyono *et al.* 1993; Hodel *et al.* 1999; Dao Trong Hung *et al.* 2001; Luu Ngoc Trinh *et al.* 2003; Vlkova *et al.* 2011) but it has mostly been focused on the Kinh (ethnic Vietnamese), the majority ethnic group. Only a very few studies have been done on the homegardens of ethnic minorities. In the case of the Cao Lan, a Tai speaking minority group living in the Northern Mountain region, there are only 2 brief reports (Gilligly and Nghiem Phuong Tuyen 1992; Le Trong Cuc and Rambo 2001) which describe the species composition of their homegardens but not their ecological structure or the functions of the different species.

It was in order to obtain information about the structure and species composition and functions of Cao Lan homegardens, that we carried out a short field study in a Cao Lan community in Tuyen Quang province in Northern Vietnam. This case study was done as part of a larger comparative study of the ecological structures of homegardens of different ethnic groups in Northeast Thailand and Vietnam which was designed to assess the relative importance of culture and environment as determinants of agroecosystem structure (Pijika 2014). The aims of this paper are to describe the modal ecological structure of the Cao Lan homegardens, identify all of the plant species grown in these gardens and categorize their functions, and compare the modal structure of the Cao Lan gardens with those of their Kinh neighbors and ethnically related Tai minority groups in Northeast Thailand.

## Background

### *The Cao Lan Ethnic Group*

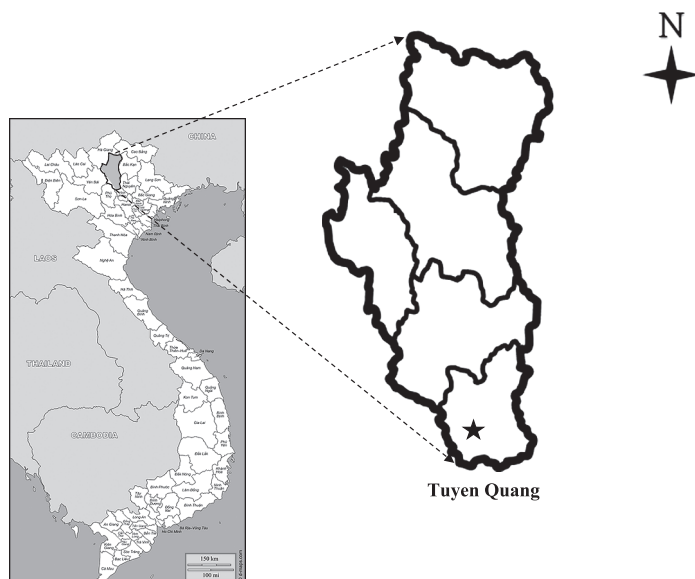
The Cao Lan speak a language belonging to the Tai family of languages. They are one of 54 officially recognized ethnic groups in Vietnam. They are known officially as San Chay (also often called Cao Lan-San Chi). They first immigrated to Vietnam from China beginning in the 1600s. The Cao Lan numbered about 169,000 people in 2009. They are mainly settled in Tuyen Quang, Bac Can, and Thai Nguyen provinces. Settlements of this ethnic group are also scattered in Yen Bai, Vinh Phuc, Phu Tho, Bac Giang, and Quang Ninh provinces (Dang Nghiem Van *et al.* 2000; Sumitre *et al.* 2003; Ethnologue: Languages of the World 2013). According to the 1999 census, a few thousand San Chay live in the Central Highlands, mostly in Dac Lac with smaller numbers in Binh Phuoc, Dong Nai, Gia Lai, and Kon Tum provinces (General Statistical Office 2001). It is likely that these people migrated south to the New Economic Zones in the 1980s.

According to Gregerson and Edmondson (1998), the Cao Lan-San Chay ethnic group is actually a composite of two groups with two different languages and two non-overlapping cultures. The Cao Lan language has been classified as a Central Tai language of the Kam-Tai sub-branch of the Tai-Kadai language family, while the San Chay language is Han Chinese. In their view “. . . the Cao Lan and San Chay do not live in a classical diglossic situation of high language vs low language, but as two groups with mostly different identities despite a small overlap today and a common link in the past,” when these groups lived in close proximity along the border areas of Hunan, Guangdong, and Guangxi provinces of China (*ibid.*, 152).

According to Gregerson and Edmondson's field study, some Tai speaking Cao Lan groups refer to themselves as San Chay, although this is the official name of the Han-speaking group. Both Cao Lan and San Chay write using Chinese characters. Some older San Chay people can also speak a Tai language just as some elderly Cao Lan can speak and write in the Han language. It can be concluded that, “All these facts tell us that the two were in some sense one nationality with two partially overlapping speech communities whose original bilingualism has developed into separated mostly monolingualism through separation, as the majority of the San Chay live in Quang Ninh and the Cao Lan live mostly in Tuyen Quang, Thai Nguyen, and Bac Giang” (*ibid.*).

### *The Study Village*

Cao Ngoi village is in Dong Loi commune, Son Duong district of Tuyen Quang province. This village is quite isolated and far away from the main road. The distance from the Son Duong district capital to the village is about 50 km, or 2 hours travel by bus (Fig. 1). The



**Fig. 1** Map Showing Location of Cao Ngoi Village, Son Duong District, Tuyen Quang Province

narrow and very rough dirt road that connects the village to the main highway crosses paddy fields in lowlands, then climbs up on to the upper terrace with sugarcane fields and acacia tree plantations, before it descends into the narrow valley hidden between steep sloped mountains where Cao Ngoi village is located.

According to the oral traditions of the villagers, Cao Ngoi village was established about 200 years ago by a group of 7 Cao Lan households who migrated there from Hoa Binh province. There are now 21 households with 76 people living there. They all speak the Cao Lan language in their daily activities in the village and also can converse in Vietnamese when dealing with outsiders. Traditionally, Cao Lan was written using Chinese characters but now only one older man in the village can read it. Nowadays the villagers wear Vietnamese style clothes for daily life but they still wear the traditional Cao Lan dress on special occasions.

The villagers live in the traditional Cao Lan style houses which are built on stilts made from large tree trunks. The bottom of each stilt rests on a large flat stone. Most houses have palm leaf roofs. Some houses have walls and floors made of wooden planks and others have woven bamboo walls and floors. They are entered by a wooden ladder on the side of the house. The space underneath the floor of the house is used to store firewood, agricultural equipment, motorcycles and bicycles, and wooden planks for house repairs. A fire-place made of clay is set on the floor of the house and is used for cooking



**Fig. 2** Traditional Cao Lan Style House and Components; (a) Cao Lan House, Well, and Courtyard, (b) Fire-place inside the House, (c) Balcony, (d) Animal Pens under the House

and heating. The ancestral shrine is mounted on a side wall of the house. Agricultural products such as rice grain and dried maize are stored inside the house. Some houses have large attached balconies built from bamboo where they do laundry and sun-dry food (Fig. 2).

The nearest neighboring Cao Lan village is about 4 km away, or 30 minutes by motorcycle, and the nearest market is about 10 km away. The nearest Kinh (ethnic Vietnamese) village is more than 5 km away. A rudimentary 1 room kindergarten in the village has 1 volunteer teacher and 2 very young students. The nearest primary and secondary schools are about 17 km away in Kinh villages. The older children have to ride bicycles to school there early in the morning and return in the afternoon. The trip takes them almost 3 hours each way.

#### *Natural Conditions of the Study Village*

Cao Ngoi village is situated at 169 m above sea level at 21°35'40.18"N, 105°20'52.38"E. The climate is classified as humid subtropical. The soil is infertile sandy loam, with poor drainage in the mountain valley. Although this area has scattered rain all year round with a mean annual rainfall of 1,500 mm (Nguyen Thi Mui 2006), there is a relatively dry

season from August through January and a relatively wet season from February through July. The rains start from late February, with the heaviest rain in July, and then decrease after that with only a slight amount of rain in December. According to the village headman mean temperatures range from 15°C in winter to 35°C in summer. In the village there is a waterfall which the villagers use for electricity generation, for daily household use, to irrigate paddy fields, and which now serves as a tourist attraction in the summer.

### *The Agricultural System and Its Components*

The agricultural system in the village includes paddy fields, upland fields, homegardens, and livestock. The total area of paddy fields is about 5 ha, with an average area per household of about 1,000 m<sup>2</sup>. Two rice crops are grown per year with an average yield of about 4 tons of unhusked rice per crop. The fields are irrigated with water from the stream flowing down from the mountainside into the village. Upland field crops are planted under 3 systems: 1) sugarcane on land belonging to the villagers (under contract to the sugar mill), 2) Acacia trees (*Acacia mangium* Willd) on their own land (under contract to the State Forest Enterprise [SFE]), and 3) Acacia on SFE land (the villagers work as wage laborers for the SFE). The 16 household-owned sugarcane fields cover 8.8 ha. The sugar mill provides the farmers with seedlings and fertilizer. After the harvest, they have to repay the cost of these inputs to the mill. Fourteen hectares, owned by 16 households, are planted with Acacia under contract to the SFE, with the owners receiving 63% of the income at harvest. On the Acacia land owned by the SFE, the villagers who are employed by the SFE receive a regular wage for caring for the trees.

Seventeen households have homegardens (*an toon* in the Cao Lan language). Homegardens include vegetable plots and fruit trees. The gardens surround the houses but are mostly sited in front of the houses. The front side of the house is determined by the location of the ancestor's shrine. Within the homegarden are the house, animal pens, fish pond, bee hives, fenced vegetable plots, fruit trees, a concrete paved area for sun-drying crops, and an old-style pit toilet located deep in the garden. The average area of homegardens in this village is almost 3 *sao* or about 1,004 m<sup>2</sup> (1 *sao* = 360 m<sup>2</sup>, the traditional measurement unit used in the Northern Vietnam region). The 2 smallest homegardens are only 1 *sao*, 6 gardens are 2 *sao*, 4 each are 3 and 4 *sao*, with the largest garden having an area of almost 6 *sao* (2,000 m<sup>2</sup>).

Livestock include about 60 cattle and buffalo, 100 goats (belonging to 5 households), 300 chickens, Muscovy ducks and geese, and 1 or 2 pigs per household. There are 11 fish ponds belonging to 11 households. Six households have honey bee hives.



## Methodology

### *Selection of Study Site and Study Households*

Cao Ngoi village was selected based on discussions with knowledgeable district officers about Cao Lan settlements that maintained their ethnic traditions and met the following criteria: 1) located in rural area, 2) ethnically homogeneous, and 3) the main purpose of their homegardens was production for household consumption. The village was also selected because it was located some distance away from Kinh villages in a remote area in the mountains, and had no recent connections with other Tai groups in Thailand.

Because of the small size of the community, it was not necessary to employ sampling. Instead, all 17 households having homegardens were included in the survey.

### *Data Collection and Data Analysis*

Data collection was carried out for 12 days during September 2012. Data were collected at two levels: 1) community level information on village history and ethnic identity was collected in semi-structured interviews with the village headman and village elders, 2) household level information was collected in semi-structured interviews with garden owners and by making direct observations of their gardens, including measurement of horizontal and vertical dimensions, and enumeration of plant species. Data were collected on homegarden components, functions of individual species, and structural characteristics (horizontal and vertical). These data were recorded on sketch maps, photographs, architectural drawings, and species checklists.

Data on all of the homegardens were entered into an Excel database, which was used to compile tables of characteristics for all gardens of households.

Data analysis employed the classification system for describing the characteristics of homegardens developed by Pijika (2014). This system includes horizontal structural dimensions, vertical dimensions, and measurement of species composition and diversity.

Horizontal dimensions include:

- Shape of planting area or plot: *Geometric* forms include plots or beds with square, rectangular, or circular shapes. *Organic* forms include planting areas with irregular or curvilinear shapes.
- Definition of boundaries of planting areas or plots: Boundaries can be *sharp* and clearly marked or *indeterminate* and ill-defined.
- Arrangement of individual plants within planting areas or beds: Individual plants can be planted in parallel lines (*lineal*) or in multiple clusters of plants, usually including representatives of two or more species (*polycentric*).

- Species composition within each plot: Planting areas or beds can be planted with only a single kind of plant species (*mono-species*) or with a mixture of two or more different species (*multi-species*).

Vertical dimensions include:

- Number of levels of vegetation: Plants of different species have different heights, which were recorded for 5 levels: Level 1 = 1 meter or less, Level 2 = 1.01–5 m, Level 3 = 5.01–10 m, Level 4 = 10.01–15 m, Level 5 = >15 m. All plants in the garden may be of the same height (*single level*) or they may have different heights (*two or more levels*).
- Canopy overlap: The share of the garden area in which the canopies of plants of different heights overlap each other (*non-overlapping*, *<50% overlapping*, *>50% overlapping*).

Species composition and diversity are measured in terms of the:

- Total number of species growing in the garden.
- Species richness, that is the number of species present by using Shannon-Wiener diversity index (H) (Magurran 1988)

$$H = -\sum_{i=1}^S p_i \ln p_i$$

where  $p_i$  is proportion of the species relative to the total number of plants, and  $S$  is the number of species recorded.

- Species abundance, that is how equally abundant the species are by using Simpson's index (D) (*ibid.*)

$$D = \frac{1}{\sum_{i=1}^S (p_i)^2}$$

where  $p_i$  is proportion of the species relative to the total number of plants, and  $S$  is the number of species recorded.



## Results and Discussion

### *The Structure of Cao Lan Homegardens*

The frequencies with which different structural characteristics of Cao Lan homegardens occur are shown in Table 1. The modal pattern of Cao Lan homegardens is organic shaped planting areas (Fig. 3a) with indeterminate boundaries (Fig. 3c), polycentric plantings (Fig. 3b) of multiple species in the same bed (Figs. 3b and 3d), and having multiple levels (Figs. 3a and 3d) of overlapping canopy layers (Fig. 3a). A large majority of homegardens (72%) have an organic shape of their planting area, 72% have an indeterminate boundary, 78% have a polycentric planting pattern, and 61% have multiple species within the same bed or planting area. All gardens have multiple vegetation levels, with the largest share

**Table 1** Modal Pattern of the Cao Lan Homegardens of Cao Ngoi Village, Tuyen Quang Province, Northern Vietnam (n = 17) (Gray shading indicates most common form)

Structural Dimension	Alternatives Forms (%)		Modal Pattern
Horizontal characteristics			
Shape of planting areas	All Geometric	0	Organic
	>50% Geometric	0	
	>50% Organic	28	
	All Organic	72	
Boundary definition of planting area	All Sharp	6	Indeterminate
	>50% Sharp	0	
	>50% Indeterminate	22	
	All Indeterminate	72	
Arrangement of individual plants within planting areas	All Lineal	11	Polycentric
	>50% Lineal	4	
	>50% Polycentric	7	
	All Polycentric	78	
Species composition within planting area	All Mono-species	22	Multi-species
	>50% Mono-species	17	
	>50% Multi-species	0	
	All Multi-species	61	
Vertical characteristics			
No. of vegetation levels	1	0	5 levels
	2	0	
	3	25	
	4	30	
	5	45	
Share of planting area covered by overlapping layers	Non-overlapping	0	Extensive
	<50% Overlap	44	
	>50% Overlap	56	



**Fig. 3** Homegardens of the Cao Lan of Cao Ngoi Village; (a) Organic, Multi-level and Overlapping Canopy, (b) Polycentric and Multi-species, (c) Indeterminate Boundary, (d) Multi-level and Multi-species

(88%) having 5 levels. More than half (56%) of the gardens have more than 50% of their planting area covered by overlapping vegetation layers.

A comparative study by Pijika (2014) of homegarden structures of 8 different ethnic groups in Northeastern Thailand and Central and Northern Vietnam, including 6 Tai groups (Phu Tai, Nyaw, Yoy, Lao, Kalaeng, and Cao Lan) and 2 Mon-Khmer groups (Viet and Kinh), identified 3 distinctive types of garden structures. The homegardens of most of the Tai groups (Kalaeng, Lao, Nyaw, Yoy, and Cao Lan) have structures that resemble the tropical forest type (Nair 2001), which is characterized by having an organic shape, indeterminate boundaries of planting areas, polycentric planting patterns, multi-species composition, multiple vegetation levels, and extensive canopy overlap. The homegardens of both of the Vietnamese groups (Viet and Kinh) have a temperate type structure (Niñez 1984), with geometric shapes, sharp boundaries, lineal planting patterns, mono-species composition, only a few levels of vegetation, and relatively limited canopy overlap. Fig. 4 compares, the modal structural pattern of the homegardens of the Cao Lan of Cao Ngoi village to that of the Yoy, a typical Tai minority group in Northeast Thailand, and the Kinh of Central Vietnam. It shows that the structure of the Cao Lan homegardens is very similar to the tropical forest type structure found among ethnically-related Tai groups in Northeast Thailand, but is very different from the temperate type garden structure of their Kinh neighbors in Vietnam.

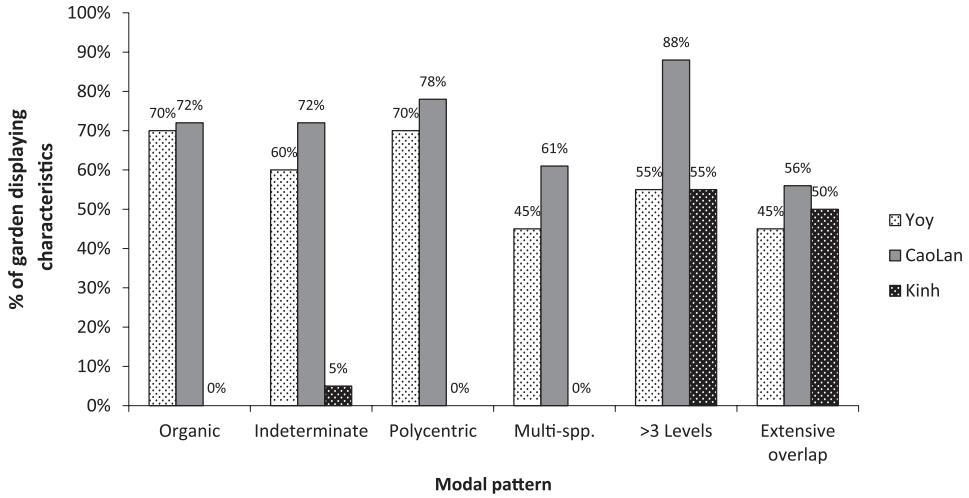


Fig. 4 Comparison of Modal Structural Patterns of Homegardens of Cao Lan with the Yoy, a Related Tai Ethnic Group in Northeast Thailand, and Their Kinh Neighbors in Vietnam (% of gardens of each group displaying characteristics)

#### *Species Composition, Diversity, and Functions*

Different plant species are scattered around in different parts of the gardens so as to optimize to their habitats in the different micro-zones of gardens. The total number of plant species found in all 17 gardens was 113. Table 2 presents a detailed list of all species grouped according to their functions. The mean number of species per garden was 25, with a range from 11 to 46 species. Six gardens had 11–20 species, 6 gardens had 21–30 species, 4 gardens had 31–40 species, and only 1 garden had more than 40 plant species.

The most common species are banana (*Musa* spp.) which was found in 15 gardens, ginger (*Zingiber officinale*) and taro (*Colocasia esculenta* Schott.) (14 gardens), guava (*Psidium* sp.) (13 gardens), Ceylon spinach (*Basella albe* L.), sweet potato (*Ipomoea batatas* [L.] Lam) and papaya (*Carica papaya*) (12 gardens), and Indian red wood (*Chukrasia tabularis* A. Juss.) (11 gardens).

Plant species richness was measured using the Shannon-Wiener's index (H), in which the higher the index number, the greater the diversity (Table 3). Species richness in the homegardens ranges from  $H = 1.25$ – $3.04$ . One homegarden had the highest richness with 35 plant species ( $H = 3.04$ ). The least rich were 2 gardens with 11 species each ( $H = 1.25$  and  $1.36$ ).

The relative abundance of species was measured using Simpson's index (D) (Table 3). Forty-seven percent of homegardens have the lowest number of plants for each spe-

**Table 2** List of Plant Species in Cao Lan Homegardens

Scientific Name	Common English Name	Cao Lan Name	Vietnamese Name	No. and Percentage of Homegardens Having Species (%)
<b>Vegetable:</b>				
<i>Corchorus olitorius</i>	Tossa jute	Phắc rau đay	Rau đay	2 (11.8)
<i>Solanum</i> spp.	Egg plant	Mặc cơ	Cây cà	8 (47.1)
<i>Solanum</i> spp.	Egg plant (purple)	Mặc cơ	Cây cà tím	5 (29.4)
<i>Luffa aegyptiaca</i> Mill.	Gourd loofa	Cơ mặc kéo	Cây mướp	7 (41.2)
<i>Basella albe</i> L.	Ceylon spinach	Cơ mùng toi	Cây mồng toi	12 (70.6)
<i>Brassica juncea</i>	Mustard greens	Phắc cật	Rau cải	10 (58.2)
<i>Perilla frutescens</i> var. <i>Crispa</i>	Shiso	Phắc hòm lằng	Cây tia tở	9 (52.9)
<i>Amaranthus gracilis</i> Desf.	Chinese spinach, Amaranth	Phắc lỏm	Rau dền	5 (29.4)
<i>Sauropus androgynus</i> (L.) Merr.	Pak wan tree, Star gooseberry	Phắc rau ngọt	Cây rau ngọt	6 (35.3)
<i>Piper sarmentosum</i> Roxb.	Wild betal leaf bush	Cơ phắc pat	Lá lốt	4 (23.5)
<i>Vigna unguiculata</i> subsp. <i>sesquipedalis</i> (L.) Verdc.	Yard long bean	Cơ mặc tở	đậu đũa	4 (23.5)
<i>Lactuca indica</i>	Indian lettuce	Phắc bầu	Bồ công anh	3 (17.6)
<i>Artemisia vulgaris</i> L.	Mugwort	Cơ ngải	Cây ngải cứu	6 (35.3)
<i>Persicaria odorata</i>	Vietnamese mint	Cơ phắc lật lẻo	Rau răm	3 (17.6)
<i>Artemisia lactiflora</i> Wall ex. Bess.	Sagebrush	Cơ phắc ngoi	Cây ngải tía	1 (5.9)
<i>Ficus</i> spp.	Ficus	Cơ lá sung	Cây sung	3 (17.6)
<i>Colocasia gigantea</i>	Colocasia	Cơ moong lính	Cây dọc mùng	10 (58.8)
<i>Vigna unguiculata</i> subsp. <i>unguiculata</i>	Cowpea	Mặc tở phùng	Cây đỗ đũa	3 (17.6)
<i>Benincasa hispida</i>	Winter melon	Cơ mặc qua	Cây bí đao	8 (47.1)
<i>Carica papaya</i>	Papaya	Cơ mặc mớ	Cây đu đủ	12 (70.6)
<i>Oroxylum indicum</i> (L.) Kurz	Broken Bones Tree	Cơ núc nác	Cây núc nác	5 (29.4)
<i>Ipomoea batatas</i> (L.) Lam.	Sweet potato	Cơ bảy mền	Cây khoai lang	12 (70.6)
<b>Spice:</b>				
<i>Citrus aurantifolia</i> (Christm.) Swingle.	Lime	Cơ mặc chanh	Cây chanh	9 (52.9)
<i>Zingiber officinale</i> <sup>b)</sup>	Ginger	Cơ hằng gừng	Cây gừng	14 (82.4)
<i>Capsicum frutescens</i> L.	Bird pepper	Cơ hằng chiu	Cây ớt	5 (29.4)
<i>Cymbopogon citratus</i> (DC.) Stapf	Lemon grass	Cơ ha hom	Cây sả	7 (41.2)
<i>Curcuma longa</i> <sup>b)</sup>	Turmeric	Cơ kinh	Cây nghệ	9 (52.9)
<i>Eryngium foetidum</i> L.	Long coriander	Phắc hòm nằm	Rau mùi tàu	5 (29.4)
<i>Ocimum basilicum</i> L.	Sweet basil	Phắc húng chó	Húng lủi	4 (23.5)
<i>Mentha cordifolia</i> Opiz.	Spearmint	Phắc hòm nhàu	Cây bạc hà	4 (23.5)
<i>Allium tuberosum</i> Rottler.ex Spreng	Chinese chive	Cà cầu sái	Cây hẹ	5 (29.4)
<i>Alpinia galanga</i> (L.) Willd.	Galangal	Cơ năng lèo	Cây giềng	4 (23.5)
<i>Atalantia citroides</i> Pierre ex Guill.	–	Cơ mặc chanh đông	Cây chanh rừng	2 (11.8)
<i>Garcinia Cowa</i> Roxb.	Garcinia	Cơ mặc lấu xong	Cây tai chua	2 (11.8)
<i>Fortunella japonica</i>	–	Cơ mặc quất	Cây quất	3 (17.6)
<i>Allium fistulosum</i>	Spring onion	Cơ xông	Cây rau hành	3 (17.6)
<i>Melissa officinalis</i> L.	Kitchen mint	Cơ phắc hom	Húng lủi	2 (11.8)
<b>Carbohydrate source:</b>				
<i>Colocasia esculenta</i> Schott.	Taro	Cơ phục	Cây môn sọ	14 (82.4)
<i>Pachyrhizus erosus</i> (L.) Urb.	Yam Bean	Cơ mền cật	Cây củ đậu	5 (29.4)
<i>Maranta arundinacea</i> L.	Arrow root	Cơ miễn tinh	Dong riềng	5 (29.4)
<i>Manihot esculenta</i> L.	Cassava	Cơ miễn mườ	Cây sắn	7 (41.2)
<i>Dioscorea bulbifera</i> L.	Aerial yam	Cơ miễn bản	Cây củ mài	2 (11.8)
<i>Vigna radiata</i>	Mungbean	Đậu nhỏ nhe	Cây đậu xanh	3 (17.6)

Table 2 Continued

Scientific Name	Common English Name	Cao Lan Name	Vietnamese Name	No. and Percentage of Homegardens Having Species (%)
<b>Fruit:</b>				
<i>Averrhoa carambola</i>	Star fruit	Cơ mặc phùng	Cây khế	8 (47.1)
<i>Psidium</i> sp.	Guava	Cơ mặc ổi	Cây ổi	13 (76.5)
<i>Musa</i> spp. <sup>9</sup>	Banana	Cơ mặc cói toí	Cây chuối tây	10 (58.8)
<i>Musa</i> spp. <sup>9</sup>	Banana	Cơ mặc cói lừng	Chuối tiêu	8 (47.1)
<i>Musa balbisiana</i> Colla <sup>9</sup>	Banana	Cơ mặc cói mỏng	Cây chuối hột	15 (88.2)
<i>Prunus armeniaca</i> L.	Apricot	Cơ mây mai	Cây mai	2 (11.8)
<i>Mangifera indica</i> L.	Mango	Cơ mặc xoài	Cây xoài	9 (52.9)
<i>Artocarpus heterophyllus</i> Lamk.	Jack fruit	Cơ mặc mẹt	Cây mít	6 (35.3)
<i>Citrus maxima</i> (Burm.f.) Merr.	Pomelo	Cơ mặc pọc	Cây bưởi	10 (58.8)
<i>Prunus persica</i> <sup>6</sup>	Peach	Cơ mặc đào	Cây đào	4 (23.5)
<i>Zizyphus mauritiana</i> Lamk.	Jujube	Cơ mặc táo	Cây táo	3 (17.6)
<i>Annona squamosa</i> L.	Sugar apple, Castard apple	Cơ mặc na	Cây na	6 (35.3)
<i>Litchi chinensis</i> L.	Lychee	Cơ mặc pai	Cây vải	4 (23.5)
<i>Ananas comosus</i> (L.) Merr.	Pineapple	Cây mắc ló	Cây dứa	3 (17.6)
<i>Syzygium jambos</i> (L.) Alston	Rose apple	Cơ soi	Cây roi	4 (23.5)
<i>Prunus salicina</i>	Plum	Cơ mặc mẩn	Cây mận	4 (23.5)
<i>Dimocarpus longen</i> Lour.	Longan	Cơ mặc nhãn	Cây nhãn	3 (17.6)
<i>Diospyros</i> spp.	Persimmon	Cơ mặc hồng	Cây hồng ngâm	5 (29.4)
<i>Manilkara zapota</i>	Sapodilla	Cơ hồng xiêm	Cây hồng xiêm	2 (11.8)
<i>Lucua mamona</i> Gaerten	Lekima, Egg tree	Mặc lai cay	Cây trứng gà	3 (17.6)
<b>Food dyes:</b>				
<i>Peristrophe bivalvis</i> L.	–	Cơ bay sơn	Cây nhuộm com	2 (11.8)
<i>Momordica cochinchinensis</i> (Lour.) Spreng	Spring bitter cucumber	Cơ mò pít	Cây gấc	5 (29.4)
<i>Boehmeria nivea</i>	Ramie	Cơ bảy dây	Lá gai	6 (35.3)
<b>Medicine:</b>				
<i>Iris domestica</i> (L.) Goldblatt & Mabb.	Blackberry lily	Cơ rê quạt	Cây rê quạt	1 (5.9)
<i>Crinum asiaticum</i> L.	Crinum lily	Cơ cun	Hoa lá náng/Tỏi lợi tía	3 (17.6)
<i>Plantago major</i> L.	Plantain	Cơ mã đề	Cây mã đề	6 (35.3)
<i>Drynaria quercifolia</i> (L.) J. Sm	Basket fern	Et tai thên	Ráng bay	1 (5.9)
<i>Ocimum gratissimum</i> L.	Tree basil	Cơ hương nhu	Cây hương nhu	7 (41.2)
<i>Zingiber cassumunar</i> Roxb.	Cassumunar ginger	Cơ kinh màng	Cây gừng dùng làm thuốc	1 (5.9)
<i>Xanthium</i> spp.	Cocklebur	Cơ phàn pọt	Cây ké	2 (11.8)
<i>Litsea cubeba</i> (Lour.) Pers	May Chang, Aromatic litsea	Mây thu hính	Cây màng tang	2 (11.8)
<i>Crinum asiaticum</i>	Crinum Lily, Cape Lily, Poison Bulb, Spider Lily	Cơ cồn	Cây lá náng	3 (17.6)
<i>Abutilon indicum</i> (L.) Sweet.	Indian mallow	Cơ cối xay	Cây cối xay	4 (23.5)
<b>Stimulants:</b>				
<i>Camellia sinensis</i> (L.) Kuntze	Tea	Cơ xa	Cây chè	2 (11.8)
<i>Areca catechu</i> Le.	Betel nut, Areca palm	Cơ mặc làng	Cây cau	9 (52.9)
<i>Piper betle</i> L. <sup>6</sup>	Betel	Cơ đau	Trầu không	5 (29.4)
<i>Nicotiana tabacum</i> L.	Tobacco	Cơ xin bay	Cây thuốc lá	2 (11.8)
<b>Aesthetic:</b>				
<i>Celosia argentea</i> L.	Cockcomb, Chinese wool	Hoa lợn cây	Hoa mào gà	4 (23.5)
<i>Gerbera jamesonii</i> Bolus	Gerbera	Va đồng tiền	Hoa đồng tiền	2 (11.8)
<i>Cymbidium aloifolium</i> (L.) Sw.	Aloe-leaved Cymbidium	Phong lan	Hoa phong lan	3 (17.6)
<i>Ficus annulata</i>	Banyan tree	Cơ xì	Cây si	3 (17.6)
<i>Rosa</i> spp.	Rose	Cơ hoa hồng	Hoa hồng	4 (23.5)
<i>Celosia cristata</i> L.	–	Cơ lân cay	Hoa mào gà	3 (17.6)
<i>Eckipja prortraja</i>	–	Cơ mây moong	Cây thực mực	3 (17.6)

Table 2 Continued

Scientific Name	Common English Name	Cao Lan Name	Vietnamese Name	No. and Percentage of Homegardens Having Species (%)
<i>Ficus bengalensis</i>	Banyan tree	Cơ mây lỏng	Cây đa	4 (23.5)
<i>Streblus asper</i> Lour.	Siamese rough bush	Cơ xích xăn	Cây đuối	2 (11.8)
<i>Portulaca grandiflora</i> Hook.	Moss-rose	Cơ mười giờ	Hoa mười giờ	1 (5.9)
<i>Chrysanthemum</i> spp.	Chrysanthemum	Cơ hoa cúc	Cây hoa cúc	2 (11.8)
<i>Rhododendron arboretum</i> Smith	Delavay's Rhododendron	Cơ va hải đường	Cây Hoa hải đường	2 (11.8)
<i>Hura crepitans</i> L.	Monkey's pistol	Cơ vòng	Cây vòng	3 (17.6)
<i>Cyperus papyrus</i> L.	Papyrus	Như	Cây lác dù	1 (5.9)
<i>Alstonia scholaris</i> (L.) R. Br.	Blackboard tree, Indian devil tree, Ditabark, Milkwood pine, White cheesewood and Pulai	Cơ enh chau	Cây Hoa sữa	3 (17.6)
<i>Arfeuillea arborescens</i> Pierre ex Radlk.	–	Cơ độc cây	Cây xương cá	4 (23.5)
<i>Mila</i> sp.	Cactus	Cơ xương rồng	Cây xương rồng	1 (5.9)
<b>Fodder:</b>				
<i>Colocasia esculenta</i> (L.) Schott.	Taro	Cơ moon	Khoai nước	8 (47.1)
<i>Sterculia lanceolate</i> Cav.	Po pha sam	Cơ mời liên	Cây săng	4 (23.5)
<i>Panicum maximum</i>	Elephant grass	Cơ cỏ voi	Cơ voi	3 (17.6)
<i>Diplazium esculentum</i> (Retz.) Sw.	Vegetable fern	Cơ mây lung	Rau đường	3 (17.6)
<i>Morus alba</i> L.	Mulberry	Cơ mây môn	Cây dâu	3 (17.6)
<b>Construction materials:</b>				
<i>Duabanga sonneratioides</i> Ham.	–	Cơ mây tùng	Cây phay	6 (35.3)
<i>Bambusa</i> spp. <sup>a)</sup>	Bamboo	Cơ mây tê lung	Cây luồng	5 (29.4)
<i>Bambusa</i> spp. <sup>a)</sup>	Bamboo	Cơ mười hóp	Cây tre	4 (23.5)
<i>Azadirachta indica</i> A. Juss.	Quinine	Môi liềm hằm	Cây xoan đầu	9 (52.9)
<i>Caesalpinia pulcherrima</i>	Peacock's Crest	Cơ phượng	Cây hoa phượng	1 (5.9)
<i>Wrightia pubescens</i>	–	Cơ mời mỏng	Cây mức lông mềm	4 (23.5)
<i>Chukrasia tabularis</i> A. Juss.	Indian red wood, Bastard cedar, Chittagong wood, Indian Mahogany, Burmese almond wood, Jamaica cedar	Cơ mai lát	Cây gỗ lát hoa	11 (64.7)
<i>Corypha lecomtei</i> L.	Lan palm	Cơ gui	Cây cọ	4 (23.5)
<b>Food wrapping:</b>				
<i>Stachyphrynium placentarium</i> (Lour.) Clausager & Borchs.	–	Cơ thông chanh	Lá dong	7 (41.2)
<b>Weaving:</b>				
<i>Gossypium hirsutum</i> L.	Cotton	Mây thông tooc	Cây bông bạc	1 (5.9)
<b>Firewood:</b>				
<i>Trema orientalis</i> (L.) Bl.	Poison Peach, Charcoal tree	Cơ tập dết	Cây hu	3 (17.6)

Notes: <sup>a)</sup> secondary function as food, <sup>b)</sup> as medicine, <sup>c)</sup> as pig fodder, <sup>d)</sup> aesthetic

cies ranging from 0.01–0.25, followed by 4 homegardens (23.5%) ranging from 0.51–0.75, and 2 homegardens (11.8%) in the range of 0.26–0.50. Only 3 homegardens (17.7%) have the highest frequency of occurrence of each species.

All species were categorized according to their primary use: food and food-related, medicine, aesthetic, stimulants, fodder, construction materials, and other uses (Table 4).

**Table 3** Species Composition and Diversity in the Cao Lan Homegardens of Cao Ngoi Village, Tuyen Quang, Northern Vietnam (n = 17)

	Diversity	No. of Homegardens (%)
Richness (Shannon-Wiener index, H)	1.01–1.50	2 (11.8%)
	1.51–2.00	5 (29.4%)
	2.01–2.50	4 (23.5%)
	2.51–3.00	5 (29.4%)
	>3.00	1 (5.9%)
Abundance (Simpson's index, D)	0.01–0.25	8 (47.0%)
	0.26–0.50	2 (11.8%)
	0.51–0.75	4 (23.5%)
	0.76–1.00	3 (17.7%)

**Table 4** Primary Functions of Plant Species in the Cao Lan Homegardens (number and percentage)

Functions (no. and % of species)	Type	No. and % of Plant Species (n=113 species)
Food 66 (58.4%)	Vegetable	22 (19.5%)
	Fruit	20 (17.7%)
	Spice	15 (13.3%)
	Carbohydrate source	6 (5.3%)
	Food dye	3 (2.6%)
Aesthetic 17 (15.0%)	Ornamental	17 (15.0%)
Medicine 10 (8.9%)	–	10 (8.9%)
Construction materials 8 (7.1%)	House repair	7 (6.2%)
	Roofing	1 (0.9%)
Fodder 5 (4.4%)	Pig	3 (2.6%)
	Cattle	1 (0.9%)
	Silkworm	1 (0.9%)
Stimulants 4 (3.5%)	–	4 (3.5%)
Other use 3 (2.7%)	Food wrapping	1 (0.9%)
	Weaving	1 (0.9%)
	Firewood	1 (0.9%)

The majority of plant species (58.4%) are used for food, followed by 17 ornamental species (15.0%), 10 medicinal species (8.9%), 8 species for construction (7.1%), 5 species for animal fodder (4.4%), 4 species used as stimulants (3.5%), and 1 species each for other



uses including food wrapping, firewood, and weaving. No species are used for ritual or to sell for cash. Only 7 species serve multiple functions: Ginger is used for spice and medicine, the fruit of three species of banana (*Musa* spp.) are used for human food and the stalks as food for pigs, and bamboo shoots are eaten as human food and the stalks used as construction materials, peach is used for food and serves an aesthetic function, and betel is used as a stimulant and for aesthetic purposes.

A small number of species are used as stimulants (areca nut [*Areca catechu* Le.] and betel leaf [*Piper betle* L.]), as food dye for cooking sticky-rice cake (spring bitter cucumber [*Momordica cochinchinnensis* (Lour.) Spreng], ramie [*Boehmeria nivea*, and *Peristrophe bivalvis* L.]), and as food-wrapping leaves [*Stachyphrynium placentarium* (Lour.) Clausager & Borchs.]. Three households have mulberry trees in their gardens, the leaves of which used to be used to feed silkworms that yielded thread that was formerly used to weave cloth and one household grows cotton, which also used to be used for weaving.

## Conclusions

The homegardens of the Cao Lan of Cao Ngoi village are an important component of their agroecosystem. The many different species of plants grown in these gardens provide food and other necessities for the people as well as fodder for their livestock. With a total of 113 species the gardens also contribute to conservation of biodiversity.

Although the Cao Lan of Cao Ngoi village have been geographically isolated from other Tai groups for many centuries, their homegardens display a tropical forest type garden structure that closely resembles that of several Tai groups in Northeast Thailand. This type of homegarden structure is very different from the temperate type structure of the gardens of their Kinh neighbors in Vietnam with whom they share a common environment and are in frequent contact. The persistence of a common structural pattern among these related Tai ethnic groups, despite their inhabiting different environments, and having had no direct contact with each other for a very long time, suggests that culture exerts a very strong influence over agroecosystem structure. This finding provides empirical support for Richard O'Connor's (1995) earlier suggestion that culture and agriculture are tightly linked together to form durable "agro-cultural complexes" that offer a useful key to reconstruction of the cultural history of Southeast Asia.

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