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Biodiversity International Journal

Native and Endangered Timber Tree Species in Homegardens of Northeast and Northcentral Vietnam

Abstract

Homegardens are receiving increasing attention for *in-situ* plant genetic conservation in biodiversity conservation programs. To inform authorities and conservation stakeholders, we investigated the diversity and provenance type of tree species in 120 homegardens in Northeast and Northcentral Vietnam. The study showed that ten of sixteen recorded timber trees are native to the country, including one (*Aquilaria crassna)* classified as 'critically endangered' two 'endangered' (*Erythrophleum fordii* and *Parashorea chinensis),* and one 'vulnerable' *(Dalbergia tonkinensis),* according to the global Red List of threatened tree species. The study provides evidence for the potential role of homegardens as plant genetic source and *in-situ* conservation, and we recommend that the Government of Vietnam recognizes this opportunity through support programs for diversification and domestication of native tree species for homegardens.

Keywords: Agro-biodiversity; Conservation status; Homegarden; *In-situ* conservation; Native tree species

Short Communication

Volume 2 Issue 2 - 2018

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Received: November 03, 2017 | **Published:** January 23, 2018

Introduction

Agro-biodiversity is the result of natural and human selection processes involving animal, plant, and micro-organisms in agricultural systems, and is important for determining the socio-economic and ecological benefits that can be derived from the systems [1]. The trend of developing monoculture agricultural systems for the sake of high productivity and economic return, however, has led agro-biodiversity into alarming level [2]. Despite the global trend, homegarden can become an avenue for investigating on-farm plant genetic resources since they often serve as refuge for native plant species and act as experimental sites when introducing new species/varieties [3]. While the socio-economic and ecological benefits of homegardens are relatively well known, nonetheless, more research is needed to understand their contributions to agro-biodiversity and *in-situ* conservation [4,5].

To avoid further degradation in current agro-biodiversity, and biological diversity in general, Vietnam has demonstrated commitment to international biodiversity conservation treaties such as Convention on Biological Diversity (CBD) by formulating conservation strategies promulgated by the Ministry of Natural Resource and Environment (MONRE). For example, in the National Biodiversity Strategy to 2020 and Vision to 2030, the government aims to conserve 'naturally important ecosystems, endangered, rare, and precious species, and genetic resources; that should be used sustainably, and contribute to the development of a green economy, and actively respond to climate change' [6]. Specifically, the target is 'to improve the quality and population of endangered, rare and precious plant and animal species, ensuring that no new case of species extinction is reported, and significantly improve the status of endangered, rare and threatened species' and 'to compile an inventory, store, and conserve native, endangered, rare and precious genetic resources to ensure that they are not impaired or eroded.

To achieve the target, the CBD and the National Biodiversity Strategy emphasize *in-situ* and the complementarity between *in-situ* and *ex-situ* conservation approaches for conserving and ensuring sustainable uses of biodiversity, and ensuring fair and equitable benefit share from the use of genetic resources. In contrast to *ex-situ*, *in-situ* conservation allows the plant evolution and adaptation process to continue in its natural habitat, and become the subject of continuous research [5]. Moreover, it also enables learning and sharing interactions between landowners, researchers, extension service and local authorities, including on the importance of conservation [5]. Despite all of these, the Vietnam National Biodiversity Strategy has indeed paid little attention to the potential role of homegarden as plant genetic source and *in-situ* conservation.

There are some policies in Vietnam, both at province and district level supporting homegarden development, for example Resolution No. 01/ NQ-HDND issued on August 5th 2016 and Resolution No. 32/NQ-HDND issued on December 15th 2016 for Ha Tinh province, Northcentral Vietnam. These policies were promulgated to meet the targets of New Rural Development Program (Decision No. 1600/QĐ-TTg issued on August 16th 2016) and "Agricultural restructuring towards raising added values and sustainable development" program (Decision No.899/QĐ-TTg issued on June 10th 2013). These policies however mainly focus on enhancing economic benefits of homegarden, for example by subsidizing seedlings of fruit trees, and formulating targeted income from supported homegardens.

The aim of our study was to document the diversity and provenance type (native vs. exotic) of tree species in homegardens

of upland communities in Northeast and Northcentral Vietnam. We focus on the provenance type and endangered status of recorded tree species in the two regions, while links between tree diversity and drivers that lead to the diversity, which has been a focus of existing studies about Vietnamese homegardens [7-10] will be covered in another paper. To our knowledge, for the case of Vietnamese homegarden, none has conducted similar study like we present here. We also aimed to provide evidence for the Government of Vietnam to pay more attention to the potential role of homegardens as plant genetic source and *in-situ* conservation.

Study area

In total 120 homegardens from four sampled communes, with 30 homegardens per commune, were investigated. In the Northeast region, the study sites are found in Dong Phuc and Hoang Tri communes, Ba Be district, Bac Kan (BK) province (22°10′N 105°50′E). Ba Be is a mountainous district with nearly 95% of its population from ethnic minorities such as Tay, Dao, and Mong [11]. In the Northcentral region, the study sites were selected in Ky Son commeune, ky Anh district and Huong Lam commune, Huong Khe district, Ha Tinh (HT) province (18°20′N 105°54′E). Both districts are coastal upland with nearly the whole population from the majority Kinh ethnic group.

Methods

The household selection was conducted with a stratified random sampling of 2-3 villages per commune. The information documented from each homegarden included vernacular name and number of standing trees of each tree species. First, the recorded tree species were classified into (a) timber trees, defined as those producing wood and/or bark as main product, or (b) non-timber trees, those for other purposes, e.g. providing fruits. Next, each tree species is classified into native or exotic, based on local and scientific knowledge. Local knowledge here refers to if the tree species is native to the commune or originated from other areas, and was based on interviews with local key informants, e.g. extension officers and commune leaders. Scientific knowledge determines the status to the country, and is based on the global classification by International Union for Conservation of Nature (IUCN) (http://www.iucnredlist.org/) or the Catalogue of life (http://www.catalogueoflife.org/). The IUCN [12] defines native species as 'a species, subspecies, or lower taxon, occurring within its natural range (past or present) and dispersal potential (i.e. within the range it occupies naturally or could occupy without direct or indirect introduction or care by humans)', and exotic species as the opposite. Furthermore, for tree species classified as native to the country, we used the IUCN Red List of threatened tree species (http://www.iucnredlist.org/) to figure out their conservation status. In the Red list, the 'threatened status' includes 'crictically endangered' defined as 'extremely high risk of extinction in the wild', 'endangered' as 'high risk of extinction in the wild', 'vulnerable' as 'high risk of endangerment in the wild', while 'lower risk' denotes 'least concern'.

For each commune, we calculated the abundance rate of each timber tree species that reflects the number of standing trees of a timber tree species relative to total number of standing trees of all timber tree species recorded in all sampled households of the commune. We also calculated the number of households that cultivate the timber tree species, and determined their provenance type based on local and scientific knowledge, and the conservation status based on the Red List.

Results and Discussion

The survey documented in total 56 tree species, in which 40 were non-timber tree species dominated by fruit trees, e.g. mango, pomelo, jackfruit, plum and guava, and 16 timber tree species (Table 1). In BK province, *Melia azedarach* was found in 12 of 30 households in Dong Phuc commune and 8 of 30 households in Hoang Tri commune, with the abundance rate of 33% and 68% respectively. Other species with high abundance rate included *Manglietia conifera* and *Chukrasia tabularis*. In HT province, *Acacia mangium* and *Aquilaria crassna* were found in 11 and 20 of the sampled 30 households in Huong Lam commune respectively, with the abundance rate of 52% and 46% respectively. In Ky Son commune, *Acacia mangium* was found in two sampled households only but its abundance rate was 97% because the two households cultivate the *Acacia* trees in plantations (Table 1). If the two households were excluded from the analysis, the abundance rate was 88% for *Aquilaria crassna* and 10% for *Melia azedarach*.

There were some disagreements between native and exotic origin, according to the local and scientific knowledge. From the 16 recorded timber tree species in both provinces, thirteen species were claimed as native to the commune according to key informants, while only ten trees are stated native to the country, according to the IUCN list (Table 1). Two tree species namely *Cinnamomum cassia* and *Senna siamea* were claimed as native to the commune, but exotic according to IUCN. Another species namely *Khaya senegalensis* was claimed as native by the key informants in Huong Lam commune, and exotic by those in Ky Son commune. According to IUCN, this tree species is exotic to the country.

While none of the 40 recorded non-timber tree species are found in the IUCN Red List of threatened tree species, eight of the 16 recorded timber species are found in the List. Out of those the status of four is of higher concern than 'lower risk': *Aquilaria crassna* is 'critically endangered', *Erythrophleum fordii* and *Parashorea chinensis* are 'endagered', and *Dalbergia tonkinensis* is 'vulnerable', while the four with 'lower risk' status are *Alstonia scholaris*, *Chukrasia tabularis*, *Ficus carica*, and *Manglietia conifera*.

Aquilaria crassna can reach up to 15-20 m at mature stage, and a stem diameter of 40-50 cm [13]. Members of *Aquilaria* spp. can produce a fragrant agarwood, namely resinous heartwood that is often used for perfume and incense. The resin is produced as response to a mould infection by *Phaeoacremonium parasitica* [14]. In Vietnam, wild *Aquilaria* in forests has been over extracted, which is why farmers in some provinces such as HT collected the seedlings from natural forests to cultivate in homegardens [13].

Erythrophleum fordii is a valuable hardwood species in Vietnam threatened by over exploitation for its timber [15]. It grows mainly in northern and central Vietnam. The tree can reach 37-45 m in height and 200-250 cm in diameter. It is often called 'ironwood',

and its quality wood can be used for flooring planks, construction, and long duration transport facilities [16]. *Parashorea chinensis* can reach 80 m in height [17] and more than 100 cm in stem diameter, hence becomes part of the top canopy in dense tropical forests. Its growing habitat is mainly in northern Vietnam, but has been decimated due to deforestation and overexploitation [18].

Table 1: Diversity and provenance type of timber tree species in homegardens of Bac Kan and Ha Tinh province (n=120 HH).

Species Name			Dong Phuc (n= 30 HH)			Hoang Tri (n= 30HH)			Huong Lam (n= 30HH)			Ky Son (n= 30HH)		
Scientific	Vernacular	English	A* (%)	HH+	Status++	A (%)	HH	Status	A (%)	HH	Status	A (%)	HH	Status
Acacia mangium	Keo	Acacia							52	11	E, E	97	2	E, E
Aquilaria crassna	Dó trầm	Agarwood							46	20	N, N	2	12	N, N
Chukrasia tabularis	Lát hoa	Indian mahogany	23	4	N,N	3	1	N, N						
Cinnamomum cassia	Quế	Cinnamon							0.01	1	N, E			
Dalbergia tonkinensis	Sưa	Sua tree	6	3	N,N	4	1	N, N	1.4	4	N, N			
Duabanga grandiflora	Cây phay	-	3	1	N,N									
Erythrophleum fordii	Lim xanh	Ironwood							0.3	2	N, N			
Eucalyptus spp.	Bạch đàn	Eucalyptus										0.01	2	E, E
Khaya senegalensis	Xà cừ	African mahogany							0.02	1	N, E	0.01	1	E, E
Manglietia conifera	Mỡ	-	35	3	N,N	24	1	N, N						
Melia azedarach	Xoan	Chinaberry	33	12	N,N	68	8	N, N	0.3	5	N, N	0.01	5	N, N
Oroxylum indicum	Nút nác	Trumpet flower	0.1	1	N,N									
Parashorea chinensis	Chò chỉ	-										0.01	1	N, N
Pinus spp.	Thông	Pine							0.01	1	N,N/E			
Senna siamea	Muồng đen	Kassod tree				1	1	N,E						
Symplocos laurina	Cây dung	-							0.04	2	N,N			

*A: Abundance Rate; +HH: Number of Households Cultivate the Tree Species; ++Status of specie (N=native or E=exotic to commune, to the country)

Dalbergia tonkinensis or 'sua tree', named after its vernacular name in Vietnamese, is a valuable timber tree species despite its comparatively low height, namely 5-13 m for mature trees. This species is native to China and Vietnam, and threatened by habitat loss and overexploitation for its valuable timber [19]. *Aquilaria crassna* was also found in homegardens of Central Vietnam [10]. The existing studies of Vietnamese homegardens that we reviewed [7-10,20] did not report any record of *Erythrophleum fordii*, *Parashorea chinensis*, and *Dalbergia tonkinensis* trees in their sampled homegardens.

Conclusion and Recommendations

The homegardens in the Northeast and Northcentral Vietnam accommodated native and endangered timber tree species, and therefore policy support for homegarden development should not lead to highly commercial and monoculture oriented homegardens that can threaten the role of homegarden as *in-situ* plant genetic source and conservation for diversity and domestication of native tree species. Homegardens should easily lend themselves to farmer's backyard as experiment sites. The current homegarden policies prioritize higher economic benefits, but they should actually be in line with the National Biodiversity Strategy that supports both *in-situ* and *ex-situ* conservation, although currently the former primarily relates to special-use forest as conservation sites. However, the National Biodiversity Strategy also encourages 'on-farm conservation'. The national and international classification lists of native endangered tree species should be coordinated. For example, *Aquilaria crassna* is in the MONRE's list of endangered species [6] but we found *Erythrophleum fordii* and *Parashorea Chinensis* which are classified as 'endangered' in the Global Red List are absent from the list.

Acknowledgement

The tree species documentation was conducted through funding from the International Fund for Agricultural Development (IFAD) and Forest, Tree and Agroforestry (FTA) program for the documentation in Huong Lam commune, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) for Ky Son commune, and the Norwegian Agency for Development Cooperation (NORAD) for the two communes in Bac Kan province. We thank Duong Minh Tuan for data collection and Nguyen Tuan Anh for helping in data analysis.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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