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Citation

Hoang, V. S. (2009, April 8). *Uses and conservation of plant diversity in Ben En National Park, Vietnam*. Retrieved from <https://hdl.handle.net/1887/13720>

Version: Corrected Publisher's Version

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Note: To cite this publication please use the final published version (if applicable).

**USES AND CONSERVATION OF PLANT SPECIES
IN A NATIONAL PARK
A CASE STUDY OF BEN EN, VIETNAM**

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Economic Botany 62 (2008): 574-593

ABSTRACT

This paper surveys the use of wild and cultivated plants by local people in Ben En National Park, Vietnam, and analyzes its impact on the conservation status of some of the utilized species. A total of 208 species used for a range of non-medicinal purposes are listed (see Hoang et al. 2008 b) for 230 medicinal plants used in the Park. Most species are used for food. The use of plants contributes very significantly to the livelihood of local people in the Park, but the current use patterns are not sustainable and would lead to local extinction of rare and endangered species if no additional conservation measures are introduced. Men are collecting non-medicinal plants more often than women. A total of 38 useful plant species are commercialized, and contribute 12% of the average income of individual households. Bamboo shoots of *Schizostachyum funghomii* (Poaceae) are the most important for income generation. The monetary equivalent of non-commercialized useful plants probably far exceeds the value of the traded plant products. Plant use is independent of the ethnicity of the different populations living in the Park. Larger households make use of a greater variety of useful plant species than small families. Abundant species in the forest have a higher use index (UI) than less common species. Out of the 208 useful species, as many as 27 were found to be endangered locally, many more than the 11 or 8 endangered species included in national or global red lists. Currently, useful plants, especially important timber trees are more abundant in the less disturbed parts of the Park, far away from the villages,

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indicating the pressures of illegal logging and harvesting near villages on the ecosystems.

Key words: Useful plants, Ben En National Park, food plants, construction, firewood, household tools, conservation, Use Index.

INTRODUCTION

Ben En National Park is one of 30 National Parks in Vietnam, established in 1992 to conserve the rich, but seriously threatened biodiversity of the country. The Ben En area was designated for the protection of fauna in 1979, and as a nature reserve in 1986, although commercial logging operations continued until 1992. The Park is inhabited by 4000 local people belonging to five ethnic groups. Although initially all uses of wild natural resources were forbidden in the National Parks, current policies in Vietnam seek to find an optimal and realistic balance between conservation and sustainable use of natural resources, also within the boundaries of the National Parks. Apart from very preliminary species surveys (Anonymous 2000; Todoff et al. 2000), very little is known of both the plant biodiversity and ethnobotany of Ben En. The current study of native and cultivated plant use in the Park forms part of a larger study including traditional medicinal plant use (Hoang et al. 2008 b) and detailed botanical plot studies analysing the effect of selective harvesting of NTFP and of illegal logging on the plant species diversity within the Park (Hoang et al. 2008 c; Hoang et al. 2008 in prep.). This knowledge is crucial for the development of a sound management policy that is both aimed at nature conservation and improving the livelihood of the local communities within the Park.

The commercial extraction of useful plants as a conservation strategy is based on the argument that forest conservation must be able to offer economic incentives to local rural people in order to counter the threat of destructive land uses such as logging, shifting cultivation, and cattle ranching (Amacher 2002; Nepstad & Schwartzman 1992; Panayotou & Ashton 1992). However, the growing commercial trade of natural products, in particular medicinal plants and woodcrafts, has resulted in increasing exploitation of wild plant populations (Lange 1998) and this has generated concern about threats for local extinction (Cunningham 2001; Clay 1997; Tiwari 2000).

Specific research questions of the present study are: 1) which plant species are used for which purpose; 2) which species are commercialized; 3) what is their relative importance for the local communities based on a use index and on monetary revenues from commercialised species; 4) what is the impact of local people on these useful plants in the wild; and 5) how do factors such as ethnicity, size of each household, and species density in the park affect plant use?

The answers to these questions can hopefully serve to model management strategies in other National Parks in Vietnam and elsewhere and contribute to the conservation of both cultural and plant diversity.

METHODOLOGY

Ethnobotanical inventory

Household surveys and interviews were carried out in 45 randomly-selected households per village (out of a total of about 110 – 150 households per village) during a 6 months field survey held from October 2005 to March 2006 by the senior author and 4 students. The standard interviews contained specific questions on age, gender and ethnic background of the gatherers and main users of plant products. Additionally we used the ‘walk-in-the-wood’ method (Prance et al. 1987), to determine which products are harvested (and for what purpose) in the forests surrounding the villages. These trips were also used to collect voucher specimens for reliable identification of the harvested plants. Special collecting trips were organized with local experts, for instance people usually collecting useful plants, or locals with a detailed knowledge of plants. Furthermore several companies making furniture in and around the research area were visited to determine which timber species were used and from which sources they came. Local names were noted during these surveys as recommended by Martin (1995). Most information was double-checked with different informants and with manuals such as the Flora of Vietnam (Ho 2000), the manual on Non timber forest products in Vietnam (Hung 2007), and the PROSEA Handbooks (1989 – 2003). Market inventories were used to determine the price of the forest products. These served as an independent way to determine which products are harvested from the surrounding forest. We also assessed local uses of these forest products.

All plants that were considered by local people to have useful properties were collected and identified. These plants not only included wild species, but also cultivated plants and wild plants that had been taken from the forest and planted in gardens or agricultural fields. One herbarium voucher of each specimen was deposited in the herbarium of the Vietnam Forestry University, additional vouchers were sent to the National Herbarium of the Netherlands (L) and specialists elsewhere for identification.

The importance of useful plant species was identified using standard Participatory Rural Appraisal (PRA) techniques (PID & NES 1989; Ngai 2001), where local people were asked to rank a list of regularly used plants. We also quantified the relative use of species by calculating a Use Index (UI) based on the proportion of households utilizing a given species (see below).

The relative importance of timber species was assessed using three criteria: (1) ranking of species from a given list by forest rangers of Ben En National Park, who were asked how often certain illegally harvested species were confiscated from local people both inside and outside the Park, (2) proportion of listed species harvested by local people, and (3) frequency of tree stumps found during the field inventory. Stumps were identified by leaves, and fruits or flowers left in the forest when the timber trees had been felled very recently or from sucker shoots when the trees had been felled a long time ago. Bark characters were also used to identify the stumps. Additionally, local informants with expertise in tree (and stump) identification assisted us.

The market demand, intensity of collection and abundance in the wild were classified as low, medium or high (based on the interviews with local people, and by using PRA techniques).

Plants were divided into five end-use categories, largely following Prance et al. (1987):

- a. Food: Any plant or plant part (fruits, seeds, leaves, bark, flowers, or latex) used for human consumption.
- b. Construction: All roundwood and sawn boards used for house frames, furniture, canoes and bridges.
- c. Household tools and related products: All plants or plant parts used for house equipment, handicrafts, tools, poisons, shampoo, candles.
- d. Medicine (see Hoang et al. 2008 b).
- e. Firewood: All plants that are used for firewood, including charcoal.
- f. Others: Plants used as ornamentals, wrapping material, or pulp and paper.

Plants with multiple uses fall in more than one category.

Plot inventory

For a detailed analysis of plant biodiversity patterns in the Park (Hoang et al. 2008 a), and to study the impact of local people on collecting useful plants in the wild (this study) we established 41 transects, 200 m long, at 250 m intervals at right angles to and along the old logging road from Song Chang forest ranger station to Cong troi. The total length of these transects combined is ca. 7.4 km. We also established four 10 x 10 m plots at 50 m from the logging road and at 40 m forward intervals on each transect, resulting in ca. 147 plots for all transects combined (in some transects we were not able to establish four plots, because of steep, inaccessible limestone slopes). In each plot of 10 x 10 m, all trees with a dbh \geq 5 cm were identified. In this study we combined four plots in each transect into one larger plot (we use the word 0.04 ha plot for these combined plots). We also established six transects to cover the rest part of the Park, with a total length of about 26 km. In each transect we noted all species and collected specimens of plants which could not be identified in the field. In all six transects we established 30 random plots of 10 x 10 m, and identified all species in the plots. Furthermore we also collected many plants outside the plots and transects, to make sure that our inventory was as representative as possible of the entire species richness of the local flora.

Data analysis

The database resulting from the ethnobotanical inventory was used to calculate a use index (UI) for each species by using the following equation:

$$UI = U_s/N$$

Where U_s is the number of households which mentioned a use for species s ; N is the total of households that were interviewed in the research area. This Use Index is a modification from the Use Value (UV) introduced by Phillips & Gentry (1993) and recently used by De Lucena et al. (2007), which is calculated from the relative number of times a species is mentioned by various informants in ethnobotanical inventories.

Simple regression analysis (SPSS 16.0) was used to examine whether the number of stumps, and distances from villages to plots relate to number of useful plants and number of important timber trees; the relation between Use Index and number of useful plant species and number of important timber trees in plots; and the number of people in each household and number of useful plant species used by their households. Additionally, we used One Way ANOVA analysis to test if the number of useful plant species used is different among ethnic groups.

RESEARCH AREA

Field work was conducted in Ben En National Park, situated in Nhu Thanh and Nhu Xuan districts of the Thanh Hoa province in Vietnam, $19^{\circ} 40' N$ by $105^{\circ} 21'$ to $105^{\circ} 35' E$ (Fig. 1.1). Before its establishment in 1986, the Park was a logging enterprise, resulting in the fact that big trees with a diameter at breast height of over one meter were rarely observed during our field work. Ben En National Park was established as a protected area in 1986 and as a National Park in 1992. Since then all logging activities are illegal. The core zone of the National Park covers 15,800 ha, while the buffer zone covers around 12,000 ha. About 18,000 people live in the buffer and core zones of the National Park (Tordoff et al. 2000). The majority of the people living in the National Park belong to the Kinh, Thai, Muong and Tay ethnic groups; although there are also a small number of Tho people. All ethnic groups have their own languages, but all can communicate in the national King (Viet) language. Most households in the research area have their own home garden, varying in size from 100 to 2,000 sq.m implying that 26% of the total land in the buffer zone is thus managed by local people. This includes 2620 ha (8.4%) of secondary forest and poor forest lands, 2256 ha (7.3%) of bare land or land with some small trees and shrubs, 443 ha (1.4%), of plantation forest and 2554 ha (8.2%) of agricultural land. There are plans to allocate more land to local households in the future. In some areas, land is being planted with sugar cane, cassava, in other areas reforestation is taking place with *Eucalyptus camaldulensis*, (Myrtaceae), *Acacia mangium*, *A. auriculiformis* (Mimosaceae), *Hevea brasiliensis* (Euphorbiaceae), and fruit trees.

The interviews were carried out in three villages: Xuan Thai, Binh Luong and Hoa Quy. Additional information on useful plants was collected in the Ben Sung, Yen Cat, and Xuan Thai markets and from several companies making furniture in and around the Park. There are nine vegetation types in Ben En National Park (Hoang et al. 2008 a): the vegetation of the core zone is dominated by tropical evergreen forest, which has been disturbed by human activities, principally by logging.

RESULTS

Diversity of useful plant species

A total of 208 plant species were found to be used by local people in Ben En National Park (excluding medicinal plant species which are surveyed elsewhere, see Hoang et al. 2008 b). These species belong to 130 genera and 64 families. A complete list of useful, non-medicinal plant species is given in Appendix 4.1.

From the 208 useful species, 59% are collected exclusively from the wild (primary, secondary and logged-over forest); 31% of the species are cultivated in home gardens or in fields and mostly used as vegetables or for their fruits, e.g. *Mangifera indica* (Anacardiaceae), *Artemisia vulgaris* (Asteraceae), *Diospyros kaki* (Ebenaceae); another 10% of the species are taken from the forest and planted in home gardens, e.g., *Garcinia cowa*, *Garcinia multiflora* (Clusiaceae), and *Dracontomelon dao* (Anacardiaceae).

Plant parts used

In Appendix 4.1 the different plant parts used of each species are indicated. Stems of trees, shrubs and lianas are most commonly used, for construction, firewood or handicrafts. Fruits and leaves are also commonly used; mostly for food. 22 species are used by local people as whole plants, mostly for ornamental purposes, e.g. *Euphorbia pulcherrima* (Euphorbiaceae), *Acanthopanax trifoliatum* (Araliaceae); some small plants are used as vegetables such as *Centella asiatica* (Apiaceae). Local people use seeds, resin, branches or bark. For instance, seeds of *Michelia tonkinensis*, *Michelia mediocris* (Magnoliaceae) are used as spice for food; resin of *Canarium album* and *Canarium tramdenum* (Burseraceae) is used for making candles. Bark of *Artocarpus tonkinensis* (Moraceae) is chewed together with leaves of *Piper betle* (Piperaceae) and fruits of *Areca catechu* (Arecaceae) - this is a traditional custom in Vietnam.

Diversity of commodity groups

Table 4.1 shows the distribution of useful plants in the five end-use categories. The different commodity groups are discussed below.

Table 4.1. Commodity groups of useful plants in Ben En National Park

Commodity group	Number of plant species	Percent/total (%)
Food	142	68
Construction	40	19
Firewood	25	12
Household tools and related products	18	9
Other	16	8

Food

Food (fruits and vegetables) is the most important end-use category. Sixty wild species are collected from the forest, e.g. leaves of *Meliantha suavis* (Opiliaceae), *Maesa balansae* (Myrsinaceae), *Vernonia solaniflora* (Asteraceae), *Callipteris esculenta* (Athyriaceae), *Erythrophalum scandens* (Olacaceae), *Schefflera octophylla* (Araliaceae), fruits of *Baccaurea ramiflora* (Euphorbiaceae), and tubers of *Dioscorea persimilis* (Dioscoreaceae). A total of 64 wild species have already been introduced in home gardens or agricultural fields such as *Polyscias fruticosa* (Araliaceae), *Telosma cordatum* (Asclepiadaceae), *Dracontomelon dao*, *Spondias lakoensis* (Anacardiaceae). All households interviewed collect bamboo shoots of *Schizostachyum funghomii* (Poaceae) for food; 32% of the households collect these shoots also for trading, both fresh and dried in local markets, and sell them to traders from Yen Cat, Ben Sung and Bai Tranh, three neighboring towns at 8–20 km distance from Ben En.

Construction

Although Ben En was established as a National Park in 1992, illegal logging is still taking place by people inside and outside the Park. A total of 40 species are used by local people for construction and furniture, e.g. *Erythrophleum fordii* (Caesalpiniaceae), *Paviesia annamensis* (Sapindaceae), *Vatica odorata* (Dipterocarpaceae), *Actinodaphne obovata* (Lauraceae), *Dysoxylum cauliflorum* (Meliaceae). Some rattan and bamboo species such as *Dendrocalamus barbatus* and *Bambusa blumeana* (Poaceae) are used for construction of animal cages (pigs, cows, buffaloes, chickens), and some households still use leaves of the palm *Livistona chinensis* for thatching. The 15 most important local timber species, according to the interviews with forest rangers and local people, and according to their stump frequency in the research plots (Hoang et al. 2008 a; Hoang et al. in prep.) are listed in Table 4.2.

Firewood

All households in the research area still depend on firewood for their cooking, also for heating and other energy sources; 25 species were recorded for firewood use; most of them are collected from the forest, and the forest land that belongs to the individual families. Small trees or branches are used that can easily be chopped into small pieces and quickly lit, from species such as *Xylopia pierrei* (Annonaceae), *Cratoxylum polyanthum* (Clusiaceae), *Melastoma normale*, or *Melastoma septemnerium* (Melastomataceae). Some cultivated species are also used such as *Acacia auriculaeformis*, *Acacia mangium* (Mimosaceae), *Eucalyptus camaldulensis* (Myrtaceae), *Pinus massoniana*, and *Pinus merkusii* (Pinaceae). Local people also make charcoal by burning the stumps and branches of *Erythrophleum fordii* (Caesalpiniaceae) that have already been cut for their timber.

Table 4.2. Important timber trees in Ben En National Park and their use index (UI)

Scientific name	Family	Use Index (UI)
<i>Actinodaphne obovata</i> Blume	Lauraceae	0.65
<i>Aglaia spectabilis</i> (Miq.) S.S. Jain & Bennet	Meliaceae	0.56
<i>Amesiodendron chinense</i> (Merr.) Hu	Sapindaceae	0.56
<i>Aphanamixis grandifolia</i> Blume	Meliaceae	0.53
<i>Dysoxylum cauliflorum</i> Hiern	Meliaceae	0.78
<i>Erythrophleum fordii</i> Oliv.	Caesalpinaceae	0.99
<i>Garcinia fagraeoides</i> A. Chev.	Clusiaceae	0.52
<i>Lagerstroemia calyculata</i> Kurz	Lythraceae	0.81
<i>Michelia mediocris</i> Dandy	Magnoliaceae	0.84
<i>Parashorea chinensis</i> Wang Hsie	Dipterocarpaceae	0.81
<i>Pavieasia annamensis</i> Pierre	Sapindaceae	0.85
<i>Peltophorum tonkinensis</i> Pierre	Caesalpinaceae	0.54
<i>Phoebe paniculata</i> Nees	Lauraceae	0.66
<i>Vatica harmandiana</i> Pierre	Dipterocarpaceae	0.54
<i>Vatica odorata</i> (Griff.) Symington	Dipterocarpaceae	0.50

Household tools and related products

A total of 18 species are used for household tools and related products, e.g. *Dendrocalamus barbatus*, *Bambusa blumeana*, and *Schizostachyum funghomii* (Poaceae) to make baskets; *Calamus balansaeamus*, *Calamus faberi*, and *Calamus tetradactylus* (Arecaceae) for handicrafts, e.g. cane chairs and tables, pillows, boxes; and *Baeckea frutescens* (Myrtaceae) for making brooms.

Other uses

Only 11 species are used as ornamental plants in the research area: e.g. *Camellia amplexicaulis* (Theaceae), *Acanthopanax trifoliatum* (Araliaceae), *Cycas revoluta* (Cycadaceae), *Barringtonia acutangula* (Lecythidaceae) and several orchid species.

Leaves of *Phrynium placentarium* (Marantaceae) are used for wrapping rice cake. Twelve species are collected for paper making, e.g. *Acacia auriculaeformis*, *Acacia mangium* (Mimosaceae), and *Schizostachyum funghomii* (Poaceae), and sold to a pulp mill in Lam Son, 15 km away from the Park. *Pterocarya tonkinensis* (Juglandaceae) is used to stupefy fish: leaves are crushed and immersed in streams and ponds as a mild fish poison that immobilises the fishes but does not affect their edibility after the fish is caught in this way.

Commercialization of useful plants

A total of 38 of the 208 useful species in the Park are commercialized. Most of these species are sold to traders or in the local markets. The commercial plant species are listed in Appendix 4.2. Of these, 14 are cultivated in home gardens, mostly as fruit trees and vegetables, e.g. *Musa paradisiaca* (Musaceae), *Citrus maxima*, *Citrus sinensis* (Rutaceae), *Psidium guajava* (Myrtaceae), *Ocimum basilicum* (Lamiaceae), *Luffa cylindrica* and *Lagenaria siceraria* (Cucurbitaceae). The remaining 24 commercial species are collected from the forest for a variety of end-uses such as resin for candle manufacturing from *Canarium album* and *Canarium tramdenum* (Burseraceae) or leaves and shoots as vegetables, e.g., from *Meliantha suavis* (Opiliaceae) and *Schizostachyum funghomii* (Poaceae). Illegal logging of 15 timber species (Table 4.2) for domestic use and trade is still ongoing. The most important species is *Erythrophleum fordii* (Caesalpiniaceae). The timber is sold to traders or furniture manufacturers.

Only 24 families collect firewood for trade, but the income from it is low. Eight families produce charcoal for trading at a price of about 6 US\$ /100 kg.

The income of each commercialized plant species is shown in Appendix 4.2.

Income of local people per household in Ben En National Park is shown in Table 4.3.

Table 4.3. Annual income per household in Ben En National Park

Resource	Income in US\$	Percentage (%)	Remarks
Agriculture	150	36	Crops such as rice and corn
Livestock	100	24	Pigs, chickens, dogs, and cows
Non-medicinal useful plants	50	12	See Appendix 4.2
Medicinal plants	45	11	See Hoang et al. 2008 a
Others	75	17	Employment, fishing, trading, etc.
Total	420	100	

Who is collecting useful plants?

From interviewing households and key informants, it emerged that men collect useful plants more often than women at almost every age level, especially in the age classes from 20 to 50 (Table 4.4). This is in contrast to medicinal plants which are chiefly collected by women (Hoang et al. 2008 b). Moreover, activities such as cutting timber, harvesting firewood, collecting honey and making charcoal are almost all carried out by men. Young people participate more actively in collecting non-medicinal useful plants than medicinal ones (Hoang et al. 2008 b). However, people younger than 25 years are less active in collecting both non-medicinal useful and medicinal plants than older people. The older people in the research area have a better knowledge of useful plants, and many young people in the research area are employed outside the Park (Hoang et al. 2008 b).

Table 4.4. Gender and age classes of local people harvesting useful plants in Ben En National Park

Age	Gender	Percentage of individuals harvesting useful plants (%)
> 50	Male	15
	Female	8
26 - 50	Male	34
	Female	23
16 - 25	Male	8
	Female	7
< 16	Male	3
	Female	2
<i>Average % of Males</i>		<i>60</i>
<i>Average % of Females</i>		<i>40</i>

Importance of useful plants for the local communities

Firewood is considered to be the most important by local people, irrespective of which species is used. All households in the study area use firewood as the main fuel to cook food for people and pigs (pigs are also an important source of income – see Table 4.3), and for heating. In fact, the prices of the alternative fuels like electricity, gas and kerosene are too high and cannot be afforded by the local people while firewood is freely available. Additional to firewood, the bamboo shoots of *Schizostachyum funghomii* (Poaceae) are also very important because they are not only collected for local consumption, but also for generating cash. The average income from this species was 13 US\$ / per year / per household in 2005. *Erythrophleum fordii* (Caesalpinaceae) is the most important timber species, not only for timber, but also for charcoal.

The use index of species varies widely (Appendix 4.1), from 0.01 to 1, indicating that some species are only used by 1% of all households (e.g. the orchid *Dendrobium aloideum* used by only two households for ornamental purposes), while others are used by virtually all households (e.g. onion, ginger, garlic, and sweet potato). Most species with an UI higher than 0.75 are cultivated food plants, but some timber trees also have a high use value such as *Erythrophleum fordii* (Caesalpinaceae) (0.99), *Pavieasia annamensis* (Sapindaceae) (0.85), *Michelia mediocris* (Magnoliaceae) (0.84), and *Parashorea chinensis* (Dipterocarpaceae) (0.81). The vast majority of species are however used by less than half of the households, and 37% of the useful species have use indices lower than 0.25.

Conservation status

A total of 8 plant species used by local people from Ben En National Park are listed in the Red Data List of IUCN (2006), and 11 species are listed in the Red Data Book of Vietnam (Ban 2007) (Table 4.5).

Table 4.5. Useful plants in Ben En National Park listed in the Red list of IUCN 2006, the Red Data Book of Vietnam (Ban 2007), and considered as threatened species in Ben En National Park on the basis of this study.

E - endangered, CR - critically endangered, V - vulnerable, R - rare, T - threatened, K - insufficiently known, LR - least concern, nl - not listed.

Species	Family	Threat category in Red book of Vietnam	Threat category in Red list of IUCN 2006	Threat category in Ben En (this study)
<i>Actinodaphne obovata</i> Blume	Lauraceae	nl	nl	T
<i>Aglaiia spectabilis</i> (Miq.) S.S. Jain & Bennet	Meliaceae	V	nl	T
<i>Alstonia scholaris</i> (L.) R. Br.	Apocynaceae	nl	LR	nl
<i>Amesiodendron chinense</i> (Merr.) Hu	Sapindaceae	nl	LR	T
<i>Aphanamixis grandifolia</i> Blume	Meliaceae	nl	nl	T
<i>Caesalpinia sappan</i> L.	Caesalpiniaceae	nl	nl	R
<i>Calamus platyacanthus</i> Warb. ex Becc	Areaceae	V	nl	R
<i>Calamus tetradactylus</i> Hance	Areaceae	nl	nl	R
<i>Canarium tramdenum</i> Chan Dinh Dai & Yakovlev	Burseraceae	V	nl	R
<i>Chukrasia tabularis</i> A. Juss.	Meliaceae	V	LR	nl
<i>Cycas chevalieri</i> Leandri	Cycadaceae	LR	CR	R
<i>Cycas revoluta</i> Thunb.	Cycadaceae	nl	nl	R
<i>Dysoxylum cauliflorum</i> Hiern	Meliaceae	V	nl	T
<i>Erythrophleum fordii</i> Oliv.	Caesalpiniaceae	nl	E	T
<i>Garcinia fagraeoides</i> A. Chev.	Clusiaceae	V	nl	E
<i>Hopea odorata</i> Roxb.	Dipterocarpaceae	nl	nl	R
<i>Hopea chinensis</i> (Merr.) Hand.-Mazz.	Dipterocarpaceae	nl	CR	R
<i>Lagerstroemia calyculata</i> Kurz	Lythraceae	nl	nl	R
<i>Manglietia fordiana</i> Oliv.	Magnoliaceae	V	nl	R
<i>Markhamia stipulata</i> (Wall.) Seem. ex Schum.	Bignoniaceae	V	nl	E
<i>Meliantha suavis</i> Pierre	Opiliaceae	V	nl	R
<i>Michelia mediocris</i> Dandy	Magnoliaceae	nl	nl	R
<i>Parashorea chinensis</i> (Wang Hsie) H. Zhu	Dipterocarpaceae	nl	E	T
<i>Pavieasia anamensis</i> Pierre	Sapindaceae	nl	nl	T

Species	Family	Threat category in Red book of Vietnam	Threat category in Red list of IUCN 2006	Threat category in Ben En (this study)
<i>Peltophorum tonkinensis</i> Pierre	Caesalpiniaceae	nl	nl	V
<i>Phoebe paniculata</i> Nees	Lauraceae	nl	nl	T
<i>Vatica odorata</i> (Griff.) Symington	Dipterocarpaceae	nl	nl	R
<i>Vatica harmandiana</i> Pierre	Dipterocarpaceae	nl	E	R
<i>Vatica subglabra</i> Merr.	Dipterocarpaceae	E	nl	E

Based on our plot inventories (density of living trees and stumps) and interviews with forest rangers and local people a total of 27 species appears to be endangered, vulnerable, rare, or threatened in the Park (Table 4.5). For instance, *Cycas revoluta*, and *Cycas chevalieri* (Cycadaceae) are rare in Ben En and local people also collect these species for ornamental purposes, although the pressure of collecting is low and the market demand is not high. All the used timber tree species are illegally exploited by local people in Ben En, and trespassers are often caught by the forest ranger of the Park. *Actinodaphne obovata*, *Phoebe paniculata* (Lauraceae), and *Erythrophleum fordii* (Caesalpiniaceae), are not difficult to find in the forest, but the intensity of harvesting these species by local people is high, and recent stumps were often seen during the field inventory. Additional species that are often confiscated by the forest ranger are *Garcinia fagraeoides* (Clusiaceae) and *Markhamia stipulata* (Bignoniaceae). These species are in high demand but rare in the forest, and thus locally endangered.

Impact of local people on useful plants

Of all useful species in the Park, 54 were recorded in the plot inventories (see Appendix 4.1). These species were further analysed for impact of local use on their occurrence and density in the plots. Most of these species are used for construction and firewood. Useful plants in general and important timber trees in particular are more abundant in remote (and less disturbed) plots than close to the villages (data not shown). Not surprisingly the density of useful plant species, especially of important timber trees is negatively correlated with the number of stumps found in each plot (Figs. 4.1 and 4.2).

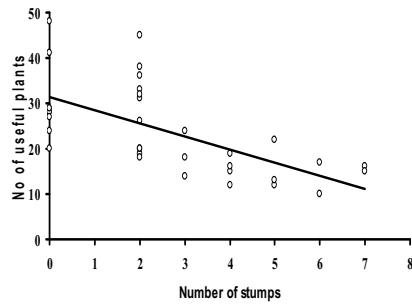


Fig. 4.1. Relation between the number of useful plants and number of stumps per 0.04 ha plot;
 $y = 30.72 - 2.84 x$; $R^2 = 0.45$

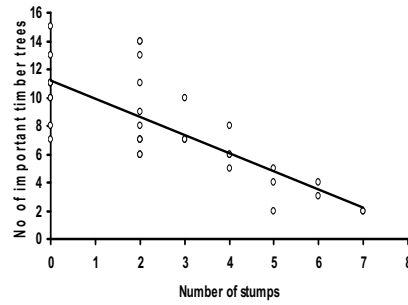


Fig. 4.2. Relation between the number of important timber trees and number of stumps per 0.04 ha plot;
 $y = 11.34 - 1.29 x$; $R^2 = 0.60$

Relation of use index, tree density, and number of people in each household

There is a strong correlation between number of people in each household and number of useful plant species used by each household in the Park (Fig. 4.3). There are also weak but significant correlations between use index and the density of useful plants (Fig. 4.4).

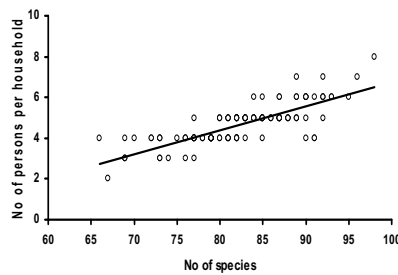


Fig. 4.3. Relation between number of persons in each household and number of useful plant species used;
 $y = 0.12 x - 5.02$; $R^2 = 0.64$

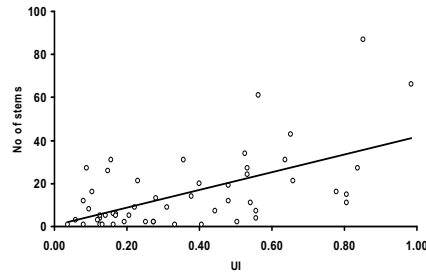


Fig. 4.4. Relation between number of stems per 0.04 ha plot and UI of 54 useful plant species;
 $y = 42.22 x + 0.56$; $R^2 = 0.34$

DISCUSSION

Conservation of useful plant species in Ben En National Park

Local people, living in and around the Park, still depend on natural resources. Dependence on these resources is highest in those communities living inside the core zone of the National Park. The remoteness of these communities makes it difficult for people to bring building materials or other plant commodities from outside the Park to their village. As a result 27 useful plant species in Ben En National

Park appear in danger of being lost locally; 16 of these are not recorded in the Red Book of Vietnam (Ban 2007). They are perhaps not only threatened in Ben En, but also in other parts of Vietnam, because the information on endangered species was - and still is - very incomplete. *Chukrasia tabularis* is listed both in the Red List of IUCN 2006, and the Red Book of Vietnam (Ban 2007); this species is endangered in nature, and it is rare in the natural forest. However, *Chukrasia tabularis* is planted widely in plantation forests in Vietnam, especially in and around Ben En National Park. Therefore we did not list this species in the list of threatened species in Ben En. Another species, *Alstonia scholaris* (Apocynaceae), listed by IUCN list (2006) is very common in plantations throughout the whole country. In contrast, *Garcinia fagraeoides* (Clusiaceae) is not on the IUCN list, but locally this species is endangered, because of the high intensity of illegal logging and its rarity in the field inventories. *Markhamia stipulata* (Bignoniaceae) was an important timber tree for local people 5 - 10 years ago. However, this species has become endangered in Ben En: only a single tree with a diameter over 5 cm was found during the field inventory.

Recently illegal logging has decreased because of the strict protection by forest rangers (Hien 2006; 2007). Local people also obtain land to plant trees. However, some illegal logging is still carried out in the Dong Tho, Song Chang, Duc Luong and Bai Tranh areas. In order to reduce the impact of local people on forest resources and to improve their living conditions, the Vietnamese Government issued Decree 02/CP in 1994, making it possible to allocate forest land to individual households for protection and re-plantation, and that policy still applies in the whole country. In some buffer zones of national parks, land is being planted with sugar cane, cassava, in others reforestation is taking place with *Eucalyptus camaldulensis*, *Acacia mangium*, *Acacia auriculiformis* and various fruit trees. This could reduce the pressure from local people on the Park in general, and in the core zone in particular. Additionally local people should be encouraged to cultivate plant species in home gardens, using modern techniques that would increase the yield of commonly used and commercialized species.

Impact of local people on useful plants

Our analysis of the occurrence and densities of useful plants in the plots (only 54 species out of the 208) has shown a significant and negative impact of harvesting and illegal logging near villages. It must be feared that – without appropriate measures - plant resources will in future also become depleted in more remote areas. A more detailed assessment of the impact of local people on plant species diversity and species densities throughout the Park is currently in preparation (Hoang et al. in prep.).

Some factors affecting plant use

We found no differences between the different ethnic groups and plant use (data not shown), but instead a significant relationship between the size of households and the number of species used per household. According to Phillips & Gentry (1993); Johns et al. (1990) and De Lucena et al. (2007) traditional plant use is strongly influenced

by factors such as abundance in the forest, and plant size and conspicuousness of individual species. Our analysis of the Use Index (UI) and other indicators of plant uses such as species ranking by informants and commercial value to some extent confirm this: in the plots species with a high UI are indeed more common than species with a low UI (Fig. 4.4), and all very useful commercial timber trees (both by species ranking and high UI, Table 4.1) are indeed big and conspicuous. There are however major exceptions to these trends: several important timber tree species with high UI are of very infrequent occurrence in all plots, e.g. *Vatica odorata* (UI = 0.50), *Parashorea chinensis* (0.81), *Amesiodendron chinense* (0.56), and *Garcinia fagraeoides* (0.52) (Hoang et al. in prep.). Also, several species with very high UI are inconspicuous and small plants in the forest, e.g. *Artemisia vulgaris* (0.52), *Hydrocotyle sibthorpioides* (0.67), *Bauhinia coccinea* (0.69), and *Perilla frutescens* (0.57) (cf. Appendix 4.1). For many cultivated plant species there is an interesting discrepancy between the calculated UI and the relatively low ranking given in the PRA questionnaires (results not shown), suggesting that local people take many cultivated species “for granted” in their response to our interviews using PRA techniques.

The Use Index spectrum for non-medicinal useful plants is quite different from that of medicinal plants (Hoang et al. 2008 b): for medicinal plant species the vast majority (68%) has low UI values (< 0.25), and only 8% have high values > 0.75 (for the non-medicinal plants these values are 32% and 16% respectively). This indicates that traditional medicinal use of wild plant species is less common than the use of non-medicinal plants, perhaps because in many households the knowledge of or confidence in the therapeutic efficacy of a certain species is low, while non-medicinal uses are much more straightforward.

Valuation of traditional plant use

The contribution of non-medicinal and medicinal plants collected in the wild or grown in home gardens to income generation was calculated to amount to 23% or 95 US\$ per household per annum (Table 4.3). These figures are only rough approximations since they are based on interviews of local people and market inventories, each with their own sources of error and imprecision. Nevertheless the total economic value of traditional plant use far exceeds this monetary component for the people of Ben En National Park, since it offers important commodities such as vegetables, fruits, condiments, fuel, construction materials, medicines, etc., “free of monetary charge”, but in return for fairly light collecting and plant cultivation efforts. It would be interesting to calculate the monetary equivalents for all these free commodities, but our data unfortunately do not allow this. Conversely, the costs of overexploitation and ecological degradation should also be modeled: an even more difficult exercise, beyond the scope of this study.

APPENDIX 4.1
Plant species used by local people in Ben En National Park

Key: Wild/Cultivated: W: Wild; C: Cultivated

*: Species are also used for medicinal plant purposes (Hoang et al. 2008 b)

+: Species recorded in plots

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
Ferns					
Gleicheniaceae	Họ Guột				
<i>Dicranopteris linearis</i> (Burm.) Underw.	Guột	0.28	W	Whole plant	Firewood
Marsileaceae	Họ Rau Bọ				
<i>Marsilea quadrifolia</i> L.*	Rau bọ	0.14	W	Leaves	Food
Woodsiaceae	Răng gỗ nhỏ				
<i>Diplazium esculentum</i> (Retz.) Sw.	Rau rón	0.30	W	Leaves	Food
Gymnosperms	Ngành Thông				
Cycadaceae	Họ Tuế				
<i>Cycas chevalieri</i> Leandri	Nghèn	0.12	W	Whole plant	Ornamental
<i>Cycas revoluta</i> Thunb.	Vạn tuế	0.08	W	Whole plant	Ornamental
Gnetaceae	Họ Dây gắm				
<i>Gnetum gnemon</i> L.	Gắm	0.29	W	Fruit	Food
Pinaceae	Họ Thông				
<i>Pinus massoniana</i> D. Don	Thông đuôi ngựa	0.33	W,C	Branch, stem	Construction, firewood
<i>Pinus merkusii</i> Jungh. & de Vriese	Thông nhựa	0.36	W,C	Branch, stem	Construction, firewood

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
Angiosperms	Ngành Ngọc Lan				
Dicotyledons	Lop Ngọc Lan				
Amaranthaceae	Họ Rau Dền				
<i>Alternanthera sessilis</i> (L.) A. DC.	Rau diếp đại	0.24	W	Leaves	Food
<i>Amaranthus spinosus</i> L.	Dền cơm	0.26	C	Leaves	Food
<i>Amaranthus tricolor</i> L.	Dền tía	0.08	C	Leaves	Food
Anacardiaceae	Họ Xoài				
<i>Dracontomelon dao</i> (Blanco) Merr. & Rolfe	Sấu	0.19	W,C	Fruit, leaves, stem	Food, construction
<i>Mangifera indica</i> L.	Xoài	0.43	C	Fruit	Food
<i>Mangifera reba</i> Pierre	Quáo	0.06	W,C	Fruit	Food
<i>Spondias axillaris</i> Roxb.	Xoan nhừ	0.08	W	Fruit	Food
<i>Spondias lakoensis</i> Pierre * +	Dâu da xoan	0.25	W,C	Fruit	Food
Annonaceae	Họ Na				
<i>Annona squamosa</i> L. *	Na	0.16	C	Fruit	Food
<i>Xylopia vielana</i> Hance * +	Dền	0.91	W	Stem	Firewood
Apiaceae	Họ Hoa Tán				
<i>Anethum graveolens</i> L.	Thì là	0.27	C	Leaves, stem	Food
<i>Centella asiatica</i> (L.) Urb. *	Rau má	0.30	W	Whole plant	Food
<i>Coriandrum sativum</i> L.	Rau mùi	0.32	C	Leaves, stem	Food
<i>Eryngium foetidum</i> Thunb.	Mùi tàu	0.31	C	Leaves, stem	Food
<i>Hydrocotyle sibthorpioides</i> Lamk.	Rau má	0.67	W	Whole plant	Food

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
Apocynaceae					
<i>Alstonia scholaris</i> (L.) R. Br. *	Họ Trúc Đào Sữa	0.04	W	Whole plant	Ornamental
<i>Holarrhena antidysenterica</i> Wall.	Mộc hoa trắng	0.04	W	Whole plant	Ornamental
Aquifoliaceae					
<i>Ilex macrocarpa</i> Oliv.	Bùi quả to	0.07	W	Leaves	Drink
<i>Ilex rotunda</i> Thunb. +	Nhựa ruồi	0.08	W	Leaves	Drink
Araliaceae					
<i>Acanthopanax aculeatum</i> Seem.	Họ Ngũ ra bì Ngũ ra bì	0.07	W	Whole plant	Ornamental
<i>Polyscias fruticosa</i> Harms	Đinh lăng	0.42	C	Leaves	Food
<i>Schefflera alpina</i> Grushv. & Skvortz.	Chân chim	0.30	W	Leaves	Food
<i>Schefflera octophylla</i> Harms *+	Chân chim 8 lá	0.48	W	Leaves	Food
Asclepiadaceae					
<i>Telosma cordata</i> Merr.*	Họ Thiên lý Thiên lý	0.26	C	Flower	Food
Asteraceae					
<i>Artemisia japonica</i> Thunb.	Họ Cúc Ngải cứu rừng	0.16	W	Leaves	Food
<i>Artemisia vulgaris</i> L. *	Ngải cứu	0.52	C	Leaves	Food
<i>Gynura crepidioides</i> Benth *	Rau tàu bay	0.21	W	Leaves	Food
<i>Lactuca indica</i> L.	Bồ công anh	0.36	W	Leaves	Food
<i>Vernonia andersonii</i> C. B. Clarke	Dây rau rầu	0.22	W	Leaves	Food
Basellaceae					
<i>Basella alba</i> L.	Họ Mồng tơi Mồng tơi	0.70	C	Leaves	Food

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
Bignoniaceae					
Họ Đỉnh					
<i>Markhamia stipulata</i> Seem. ex Schum. +	Đỉnh	0.41	W	Stem	Construction
<i>Oroxylum indicum</i> (L.) Benth. ex Kurz* +	Núc nác	0.13	W	Fruit	Food
Brassicaceae					
<i>Brassica chinensis</i> L.	Cải bẹ trắng	0.91	C	Leaves	Food
<i>Brassica integrifolia</i> West.	Cải ngọt	0.73	C	Leaves	Food
<i>Brassica juncea</i> (L.) Czern.	Cải canh	0.74	C	Leaves	Food
<i>Raphanus sativus</i> L.	Cải củ	0.70	C	Leaves, tuber	Food
Burseraceae					
Họ Trám					
<i>Canarium album</i> Roesch. +	Trám trắng	0.53	W	Resin, fruit	Candles, food
<i>Canarium tonkinensis</i> L. +	Trám chim	0.27	W	Resin, fruit	Candles, food
<i>Canarium trandenum</i> Chan Dinh Dai & Yakovlev +	Trám đen	0.53	W	Resin	Candles
Caesalpinaceae					
Họ Vang					
<i>Bauhinia coccinea</i> DC.	Quạch	0.69	W	Stem	Drink
<i>Bauhinia variegata</i> L.	Ban	0.04	W.C	Whole plant	Ornamental
<i>Caesalpinia sappan</i> L. *	Vang	0.07	W	Stem, branch	Drink
<i>Erythrophloeum fordii</i> Oliv. +	Lim xanh	0.99	W	Stem	Construction
<i>Gleditsia australis</i> Hemsl. ex Forb. & Hemsl. +	Bồ kết	0.25	W	Fruit	Shampoo
<i>Peltophorum tonkinensis</i> Pierret	Lim xệt	0.54	W	Stem	Construction
<i>Tamarindus indica</i> L.	Me	0.20	W	Fruit	Food
Caricaceae					
Họ Đu đủ					

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Carica papaya</i> L. *	Đu đủ	0.40	C	Fruit	Food
Clusiaceae					
<i>Cratogeomys polyanthum</i> Korth. *	Họ Màng cụt Thành nganh	0.18	W	Whole plant	Firewood
<i>Garcinia cowa</i> Roxb.	Tai chua	0.16	W,C	Fruit, leaves	Food
<i>Garcinia fagraeoides</i> A. Chev.+	Trai lý	0.52	W	Stem	Construction
<i>Garcinia multiflora</i> Champ. ex Benth.	Độc	0.22	W,C	Fruit, leaves	Food
<i>Garcinia oblongifolia</i> Champ. ex Benth. *+	Bứa	0.23	W	Fruit, leaves	Food
Convolvulaceae					
<i>Ipomoea aquatica</i> Foir.	Họ Bìm bịp Rau muống	0.99	C	Leaves, stem	Food
<i>Ipomoea batatas</i> (L.) Lam	Khoai lang	0.99	C	Tuber, leaves	Food
Cucurbitaceae					
<i>Benincasa hispida</i> (Thunb.) Cogn.	Bí xanh	0.27	C	Fruit	Food
<i>Cucurbita maxima</i> Lam. *	Bí đỏ	0.30	C	Fruit	Food
<i>Lagenaria siceraria</i> (Molina) Standley	Bầu	0.26	C	Fruit, leaves	Food
<i>Luffa aegyptiaca</i> M. Roem.	Mướp	0.88	C	Fruit	Food
<i>Momordica charantia</i> L.	Mướp đắng	0.20	C	Fruit	Food
<i>Momordica cochinchinensis</i> (Lour.) Spreng. *	Gấc	0.42	C	Fruit	Food
Dilleniaceae					
<i>Dillenia heterosepala</i> Finet & Gagnep.	Họ Sỗ Lọng bàng	0.10	W	Fruit, stem	Food, firewood
<i>Dillenia indica</i> L.+	Sỗ	0.10	W	Fruit, stem	Food, firewood
Dipterocarpaceae					

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Hopea odorata</i> Roxb.	Sao đen	0.56	W	Stem	Construction
<i>Hopea chinensis</i> (Merr.) Hand.-Mazz.+	Sao	0.39	W	Stem	Construction
<i>Parashorea chinensis</i> Wang Hsie +	Chò chí	0.81	W	Stem	Construction
<i>Vatica harmandiana</i> Pierre+	Tầu nước	0.54	W	Stem	Construction
<i>Vatica odorata</i> (Griff.) Symington+	Tầu mật	0.50	W	Stem	Construction
<i>Vatica subglabra</i> Merr.	Tầu xanh	0.20	W	Stem	Construction
Ebenaceae	Họ Thi				
<i>Diospyros decandra</i> Lour. *	Thị	0.42	C	Fruit	Food
<i>Diospyros kaki</i> L.f.	Hồng	0.33	C	Fruit	Food
Elaeagnaceae	Họ Nhót				
<i>Elaeagnus bonii</i> Lecomte *	Nhót	0.18	W	Fruit	Food
<i>Elaeagnus tonkinensis</i> Serv.	Nhót nhà	0.33	C	Fruit	Food
Euphorbiaceae	Họ Thầu Dấu				
<i>Baccaurea ramiflora</i> Lour. *+	Dầu da đất	0.44	W	Fruit	Food
<i>Bischofia javanica</i> Blume *+	Nhội	0.21	W	Leaves	Food
<i>Breynia fleuryi</i> Beille *	Bồ cu vẽ	0.05	W	Leaves	Food
<i>Euphorbia hirta</i> L. *	Cỏ sữa	0.10	W	Whole plant	Drink
<i>Euphorbia pulcherrima</i> Willd ex Klotzsch	Trang nguyên	0.06	W,C	Whole plant	Ornamental
<i>Macaranga denticulata</i> Mull. Arg.+	Lá nén	0.10	W	Stem	Firewood
<i>Mallotus paniculatus</i> (Lam.) Mull. Arg.+	Ba soi	0.38	W	Stem	Firewood
<i>Manihot esculenta</i> Crantz	Sắn	0.80	C	Tuber	Food

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Phyllanthus emblica</i> L.	Me rừng	0.19	W	Fruit	Food
<i>Sauropus androgynus</i> Merr.	Rau ngót	0.39	C	Stem	Food
<i>Vernicia montana</i> Lour.+	Trầu	0.17	W,C	Fruit	Oil, firewood
Fabaceae	Họ Đậu				
<i>Lablab purpureus</i> (L.) Sweet	Đậu ván	0.29	C	Fruit	Food
<i>Pachyrhizus erosus</i> (Lour.) Merr.	Củ đậu	0.19	C	Tuber	Food
<i>Pueraria phaseoloides</i> Benth.*	Sắn dây	0.33	C	Tuber	Food
<i>Sophora japonica</i> L. *	Hoè	0.21	W,C	Flower, fruit	Drink
<i>Tephrosia candida</i> DC.	Cốt khí	0.16	W,C	Whole plant	Firewood
<i>Vigna radiata</i> (L.) Wilczek.	Đậu xanh	0.42	C	Fruit	Food
<i>Vigna unguiculata</i> (L.) Walp.	Đậu đen	0.45	C	Fruit	Food
Fagaceae	Họ Dẻ				
<i>Castanopsis boisii</i> Hickel & Camus+	Dẻ ăn quả	0.14	W	Fruit, stem	Food, construction
<i>Castanopsis indica</i> A. DC.+	Cà ổi	0.13	W	Stem	Firewood, construction
<i>Lithocarpus pseudosundaiicus</i> (Hick. & A. Camus) A. Camus+	Sỏi xanh	0.17	W	Stem	Construction
<i>Quercus platycalyx</i> Hick. & A. Camus+	Dẻ cau	0.12	W	Stem	Construction
Flacourtiaceae	Họ Mông quán				
<i>Flacourtia balansae</i> Gagnep.+	Mông quán	0.09	W	Fruit	Food
Hamamelidaceae	Họ Sau sau				
<i>Liquidambar formosana</i> Hance	Sau sau	0.26	W	Leaves, resin	Food, candle

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
Juglandaceae					
<i>Engelhardtia chrysolepis</i> Hance+	Hồ đào	0.22	W	Stem	Firewood
<i>Pterocarya tonkinensis</i> Dode	Chẹo tía Cói	0.13	W	Leaves	Fishing
Lamiaceae					
<i>Acrocephalus indicus</i> Kuntze	Họ Hoa môi	0.41	W	Stem, leaves	Drink
<i>Mentha crispa</i> L.	Nhân trần	0.53	C	Leaves	Food
<i>Ocimum basilicum</i> L.	Húng	0.42	C	Leaves	Food
<i>Perilla frutescens</i> Britton	Tía tô	0.57	C	Leaves	Food
Lauraceae					
<i>Actinodaphne obovata</i> Blume+	Họ Long não	0.65	W	Stem	Construction
<i>Beilschmiedia poilanei</i> H. Liou+	Song xanh	0.04	W	Stem	Construction
<i>Beilschmiedia ferruginea</i> H. Liou+	Cháp	0.16	W	Stem	Construction
<i>Cinnamomum cassia</i> Blume *	Cháp xanh	0.50	W,C	Bark	Spice
<i>Liisea cubeba</i> Pers. *	Quế	0.38	W	Leaves, fruit	Spice
<i>Machilus bonii</i> Lecomte+	Mãng tang	0.40	W	Stem	Construction
<i>Phoebe paniculata</i> Nees+	Kháo vàng	0.66	W	Stem	Construction
Lecythidaceae					
<i>Barringtonia acutangula</i> (L.) Gaertn.	Kháo nước	0.04	W, C	Whole plant	Ornamental
Lythraceae					
<i>Lagerstroemia calyculata</i> Kurz+	Họ Sang lẻ	0.81	W	Stem	Construction
Magnoliaceae					
	Họ Ngọc Lan				

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Manglietia conifera</i> Dandy	Mỡ	0.32	W,C	Stem	Construction
<i>Manglietia fordiana</i> Oliver+	Vàng tâm	0.29	W,C	Stem	Construction
<i>Michelia mediocris</i> Dandy+	Giổi xanh	0.84	W	Seed, stem	Spice, construction
<i>Michelia tonkinensis</i> A. Chev.+	Giổi bắc bộ	0.24	W	Seed, stem	Spice, construction
Melastomataceae	Họ Mua				
<i>Melastoma normale</i> D. Don *	Mua	0.12	W	Stem, fruit	Firewood, Food
<i>Melastoma septemnerium</i> Merr.	Mua đôi	0.28	W	Stem, fruit	Firewood, Food
Meliaceae	Họ Xoan				
<i>Aglaita spectabilis</i> (Miq.) S.S. Jain & Bennet+	Gội nếp	0.56	W	Stem	Construction
<i>Aphanamixis grandifolia</i> Blume+	Gội trắng	0.53	W	Stem	Construction
<i>Chukrasia tabularis</i> A. Juss.	Lát hoa	0.52	W,C	Stem	Construction
<i>Dysoxylum cauliflorum</i> Hiern+	Đinh hương	0.78	W	Stem	Construction
<i>Melia azedarach</i> L. *	Xoan ta	0.61	C	Stem	Construction
Mimosaceae	Họ Trinh nữ				
<i>Acacia auriculataeformis</i> A. Cunn. ex Benth.	Keo lá tràm	0.90	C	Stem	Construction, paper, firewood
<i>Acacia mangium</i> Willd.	Keo Tai tượng	0.87	C	Stem	Construction, paper, firewood
Moraceae	Họ Dâu tằm				
<i>Anitarius toxicaria</i> Lesch.+	Sùi	0.31	W	Bark, stem	Twine, firewood
<i>Artocarpus heterophyllus</i> Lam.	Mít	0.65	C	Fruit, stem	Food, Firewood
<i>Artocarpus tonkinensis</i> A. Chev. *	Chay	0.16	W,C	Fruit, bark	Food, chewing betel
<i>Broussonetia papyrifera</i> Vent. *	Dưỡng	0.07	W	Leaves, stem	Firewood, twine

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Ficus auriculata</i> Lour. *+	Vả	0.23	W	Fruit, stem	Food, firewood
<i>Morus alba</i> L.	Dâu tằm	0.22	C	Fruit	Food
Myrsinaceae	Họ Đon nem				
<i>Embelia laeta</i> Mez	Ngút trắng	0.19	W	Leaves	Food
<i>Embelia oblongifolia</i> (Benth.) Hemsl.	Chua ngút lá dài	0.10	W	Leaves	Food
<i>Maesa balansae</i> Mez	Đon nem	0.11	W	Leaves	Food
Myrtaceae	Họ Sim				
<i>Baeckea frutescens</i> L.	Thanh Hao	0.09	W	Whole plant	Brooms, firewood
<i>Cleistocalyx operculatus</i> Merr. & L.M. Perry	Trám với	0.19	W	Leaves	Drink
<i>Eucalyptus camaldulensis</i> Dehnh. *	Bạch đàn trắng	0.58	C	Stem	Construction, firewood, paper
<i>Psidium guajava</i> L. *	ổi	0.68	C	Fruit	Food
<i>Rhodomerytus tomentosa</i> Hassk. *	Sim	0.38	W	Fruit	Food
<i>Syzygium polyanthum</i> Walp. +	Sán thuyên	0.28	W	Leaves	Food
Oleaceae	Họ Bù Khai				
<i>Erythralium scandens</i> Blume	Bù Khai	0.37	W	Leaves	Food
Opiliaceae	Họ Rau sáng				
<i>Meliantha suaveis</i> Pierre+	Rau sáng	0.58	W	Leaves	Food
Oxalidaceae	Họ Chua me				
<i>Oxalis corniculata</i> L. *	Chua me	0.25	W	Whole plant	Food
Piperaceae	Hồ tiêu				
<i>Piper betle</i> L. *	Trầu không	0.53	C	Leaves	Chewing betel

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Piper lolot</i> C. DC. *	Lá lốt	0.96	W, C	Leaves	Food
Rhamnaceae	Họ Táo				
<i>Ziziphus mauritiana</i> Lam. *	Táo nhà	0.92	C	Fruit	Food
<i>Ziziphus oenoplia</i> (L.) Mill.	Táo rừng	0.42	W	Fruit	Food
Rosaceae	Họ Hoa Hồng				
<i>Rubus alcaefolius</i> Poir.	Mán xôi	0.60	W	Fruit	Food
<i>Rubus cochinchinensis</i> Tratt. *	Ngây	0.36	W	Fruit	Food
Rutaceae	Họ Cam				
<i>Acronychia pedunculata</i> Miq.	Bưởi bung	0.53	W	Fruit	Food
<i>Clausena dunniana</i> H.Lev. +	Hồng bì rừng	0.36	W	Fruit	Food
<i>Clausena indica</i> Oliver+	Mắc mật	0.33	W	Fruit	Food
<i>Clausena lansium</i> Skeels *+	Hồng bì	0.19	C	Fruit	Food
<i>Citrus aurantifolia</i> Swingle	Chanh	0.95	C	Fruit, leaves	Food
<i>Citrus maxima</i> Osbeck	Bưởi	0.81	C	Fruit	Food
<i>Citrus sinensis</i> Osbeck	Cam	0.79	C	Fruit	Food
Sapindaceae	Họ Bò hòn				
<i>Amesiodendron chinense</i> (Merr.) Hu+	Trưởng Sàng	0.56	W	Stem	Construction
<i>Dimocarpus longan</i> Lour.	Nhãn	0.96	C	Fruit	Food
<i>Litchi chinensis</i> Sonn.	Vải	0.95	C	Fruit	Food
<i>Mischocarpus pentapetalus</i> Radlk.+	Trưởng ken	0.15	W	Stem	Construction
<i>Pavieasia annamensis</i> Pierre+	Trưởng mật	0.85	W	Stem	Construction

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
Sapotaceae					
<i>Achras sapota</i> L.	Hồng xiêm	0.19	C	Fruit	Food
<i>Chrysophyllum cainito</i> L.	Vú sữa	0.20	C	Fruit	Food
<i>Pouteria sapota</i> (Jacq.) H. E. Moore & Stearn	Trứng gà	0.50	C	Fruit	Food
Theaceae					
<i>Camellia amplexicaulis</i> Cohen-Stuart+	Hải đường	0.23	W	Whole plant	Ornamental
<i>Camellia sinensis</i> Kuntze *	Chè	0.94	C	Leaves	Drink
Tiliaceae					
<i>Microcos paniculata</i> L.+	Họ Đay	0.16	W	Stem	Firewood
Ulmaceae					
<i>Trema orientalis</i> (L.) Blume *	Hu đay	0.22	W	Stem	Firewood
Monocotyledons					
Alliaceae					
<i>Allium fistulosum</i> L. *	Hành	0.99	C	Whole plant	Spice, food
<i>Allium sativum</i> L. *	Tỏi	1.00	C	Whole plant	Spice, food
Areaceae					
<i>Areca catechu</i> L. *	Cau	0.56	C	Fruit, stem	Chewing betel, firewood
<i>Calamus balansaeanus</i> Becc.	Mây nước	0.36	W	Stem	Handicrafts
<i>Calamus fabri</i> Becc.	Mây thủ công	0.19	W	Stem	Handicrafts
<i>Calamus platyacanthus</i> Warb. ex Becc.	Song mật	0.36	W	Stem	Handicrafts
<i>Calamus tetradactylus</i> Hance	Mây mật	0.79	W	Stem	Handicrafts

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Caryota mitis</i> Lour. *	Đùng đình	0.21	W	Stem	Handicrafts, food
<i>Cocos nucifera</i> L.	Dừa	0.67	C	Fruit, stem	Food, firewood
<i>Daemonorops longispathus</i> Becc.	Hèo	0.38	W	Stem	Handicrafts
<i>Livistona chinensis</i> (Jacq.) R. Br. & Mart.	Cọ	0.35	C	Leaves, fruit	Oil, roofs
Costaceae	Họ Mía dò				
<i>Costus speciosus</i> (Koenig) Smith	Mía dò	0.36	W	Stem	Food
Dioscoreaceae	Họ Củ nâu				
<i>Dioscorea cirrhosa</i> Lour. *	Củ nâu	0.34	W	Tuber	Food
<i>Dioscorea persimilis</i> Prain & Burk. *	Củ mài	0.19	W	Tuber	Food, to plaster board
Marantaceae	Họ Lá Dong				
<i>Phrynium placentarium</i> (Lour.) Merr.	Lá dong	0.95	W	Leaves	Wrapping cakes
Musaceae	Họ Chuối				
<i>Musa acuminata</i> Colla	Chuối rừng	0.21	W	Fruit, flower bud, stem	Food
<i>Musa balbisiana</i> Colla	Chuối hột	0.39	C	Fruit, flower bud, stem	Food
<i>Musa basjoo</i> Sieb.	Chuối ngự	0.97	C	Fruit, flower bud, stem	Food
<i>Musa paradisiaca</i> L.	Chuối tiêu	0.94	C	Fruit, flower bud, stem	Food
Orchidaceae	Họ Phong lan				

Scientific name	Common name	Use index	Wild/ Cultivated	Part utilized	Use
<i>Cymbidium lowianum</i> Reichb.f.	Phong lan	0.06	W	Whole plant	Ornamental
<i>Dendrobium aloideum</i> La Llave & Lex.	Hoàng thảo	0.01	W	Whole plant	Ornamental
Phormiaceae	Họ Hương bài				
<i>Dianella nemorosa</i> Lam. *	Hương bài	0.04	W	Whole plant	Incense
Poaceae	Họ Cỏ				
<i>Arundinaria sat</i> Balansa	Sắt	0.50	W	Stem	Firewood
<i>Bambusa blumeana</i> Schult. f.	Tre gai	0.41	C	Stem, shoot	Construction, food, tools
<i>Cymbopogon citratus</i> Stapf*	Sả	0.51	C	Tuber	Food
<i>Dendrocalamus barbatus</i> Hsueh & D.Z.Li	Luồng	0.78	C	Stem, shoot	Paper, construction, food, tools
<i>Indosasa angustata</i> McClure	Vầu dằng	0.37	W	Stem, shoot	Food, construction
<i>Indosasa sinica</i> C.D. Chu & C.S.Chao	Vầu ngọt	0.33	W	Stem, shoot	Food, construction
<i>Panicum miliaceum</i> L.	Kê	0.36	C	Seed	Food
<i>Saccharum officinarum</i> L.	Mía	0.96	C	Stem	Food
<i>Schizostachyum funghomii</i> McClure	Nứa	0.99	W	Stem, shoot	Making paper, food, tools
Zingiberaceae	Họ gừng				
<i>Curcuma longa</i> L. *	Nghệ	0.97	C	Tuber, leaves	Spice, food
<i>Curcuma zedoaria</i> Rosc.*	Nghệ đen	0.39	W,C	Tuber	Spice, food
<i>Zingiber officinale</i> Rosc. *	Gừng	0.99	C	Tuber	Spice, food

APPENDIX 4.2
Commercial useful plant species in Ben En National Park

Scientific name	Abundance in the wild or cultivated	Intensity of collection	Price in US\$	Income/ household/ year in US\$	Market demand
Anacardiaceae					
<i>Dracontomelon dao</i> (Blanco) Merr. & Rolfe	Cultivated		Not stable	0.5	Medium
<i>Mangifera indica</i> L.	Cultivated		0.07/2fruits	0.6	Medium
<i>Spondias lakoensis</i> Pierre	Cultivated		Not stable	0.1	Medium
Annonaceae					
<i>Annona squamosa</i> L.	Cultivated		0.07/3 fruits	0.6	Medium
Araliaceae					
<i>Schefflera alpina</i> Grushv. & Skvorts.	High	Medium	Not stable	0.2	Medium
<i>Schefflera octophylla</i> Harms	High	Medium	0.28/kg	1	Medium
Burseraceae					
<i>Canarium album</i> Rausch.	Medium	High	0.07/kg fruit 1.3/kg resin	2.9	Medium High
<i>Canarium tonkinensis</i> L.	Medium	High	1.3/kg resin	1.2	High
<i>Canarium trandenum</i> Chan Dinh Dai & Yakovlev	Medium	High	1.3/kg resin	1.1	High
Caesalpiniaceae					
<i>Gleditsia australis</i> Hemsl. ex Forb. & Hemsl.	Low	Medium	0.07/4 fruits	0.2	Medium
<i>Tamarindus indica</i> L.	Low	High	0.07/6 fruits	0.2	Medium
Clusiaceae					
<i>Garcinia cowa</i> Roxb.	Low	Medium	0.07/5 fruits	0.5	Medium

Scientific name	Abundance in the wild or cultivated	Intensity of collection	Price in US\$	Income/ household/ year in US\$	Market demand
<i>Garcinia multiflora</i> Champ. ex Benth.	Medium	Medium	0.07/4 fruits	0.8	Medium
Ebenaceae					
<i>Diospyros decandra</i> Lour.	Cultivated		0.07/6 fruits	0.8	Medium
<i>Diospyros kaki</i> L.f.	Cultivated		0.07/6 fruits	1.0	Medium
Euphorbiaceae					
<i>Vernicia montana</i> Lour.	Medium	High	0.17/kg fruit	0.2	Medium
Lamiaceae					
<i>Acrocephalus indicus</i> Kuntze	Medium	Medium	Not stable	0.2	Medium
Moraceae					
<i>Artocarpus tonkinensis</i> A. Chev.	Medium	High	Not stable	0.2	Medium
<i>Artocarpus heterophyllus</i> Lam.	Cultivated		0.28/fruit	0.6	Medium
Myrtaceae					
<i>Baeckea frutescens</i> L.	Medium	Medium	Not stable	0.3	Medium
<i>Psidium guajava</i> L.	Cultivated		0.07/4 fruits	1.0	Medium
Oilacaceae					
<i>Erythralium scandens</i> Blume	High	Medium	Not stable	0.2	Low
Opiliaceae					
<i>Meliantha suavis</i> Pierre	High	Medium	0.14/kg	0.5	Medium
Rutaceae					
<i>Citrus aurantifolia</i> Swingle	Cultivated		0.07/5 fruits	0.5	Medium

Scientific name	Abundance in the wild or cultivated	Intensity of collection	Price in US\$	Income/ household/ year in US\$	Market demand
<i>Citrus maxima</i> Osbeck	Cultivated		0.14/ fruits	0.6	Medium
<i>Citrus sinensis</i> Osbeck	Cultivated		0.07/3 fruits	0.8	Medium
Sapotaceae					
<i>Achras sapota</i> L.	Cultivated		0.07/5 fruits	0.5	Medium
<i>Chrysophyllum cainito</i> L.	Cultivated		0.07/5 fruits	0.7	Medium
<i>Pouteria sapota</i> (Jacq.) H. E. Moore & Stearn.	Cultivated		0.07/5 fruits	0.8	Medium
Liliopsida					
Arecaceae					
<i>Calamus balansaeanus</i> Becc.	Low	Medium	0.17/kg	1.0	Medium
<i>Calamus fabri</i> Becc.	Low	Medium	0.17/kg	1.2	Medium
<i>Calamus tetradactylus</i> Hance	Low	Medium	0.17/kg	2.6	Medium
Dioscoreaceae					
<i>Dioscorea cirrhosa</i> Lour.	High	Low	Not stable	0.3	Low
<i>Dioscorea perstiniis</i> Prain & Burk.	High	Low	Not stable	0.4	Low
Marantaceae					
<i>Phrynium placentarium</i> (Lour.) Merr.	High	Medium	0.28/100 leaves	2.7	Medium
Poaceae					
<i>Indosasa sibata</i> C.D.Chu & C.S.Chao	Medium	High	0.2/fresh kg (Bamboo shoot)	2.0	High
<i>Indosasa sibataeoides</i> McClure	Medium	High	0.2/fresh kg (Bamboo shoot)	1.8	High
<i>Schizostachyum funghonii</i> McClure	High	High	1.1/dried, 0.17 fresh kg (Bamboo shoot) 0.0014/trees	13	High