

Potential for Household-Based Conservation of Medicinal Plants in Ba Vi Commune, Hanoi

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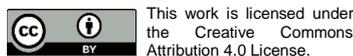
Abstract

Vietnam's favorable geographical location and climate have endowed it with a prosperous and diverse system of medicinal plants. However, illegal and unsustainable harvesting of these plants in natural forests has led to their depletion and endangerment. Ba Vi commune, located in the buffer zone of Ba Vi National Park, is home to the Dao people, who have long preserved and developed traditional medicine. This study utilized face-to-face interviews with 50 households, in-depth interviews with key stakeholders, and group discussions to assess the potential for household-based conservation of medicinal plants in Ba Vi commune. The findings revealed that over 200 medicinal plants species are exploited and used by the Dao people, including rare species such as *Stephania dielsiana* C. Y. Wu and *Asarum glabrum* Merr., among others. Despite strict legal prohibitions against exploiting forest resources in the core zone of Ba Vi National Park, 40% of interviewed households admitted to collecting medicinal plants from these protected areas. To mitigate this, the Dao people living in the buffer zone of Ba Vi National Park have been encouraged to cultivate medicinal plants to meet the demand for traditional medicine, reduce pressure on natural forests, and improve their livelihoods. However, the medicinal plant cultivation areas are currently small and fragmented. The lack of arable land, suitable plant varieties, and cultivation techniques have been considered as obstacles to expanding medicinal plant cultivation areas in the study site. Addressing these obstacles is crucial for ensuring the sustainability of the Dao community's traditional medicine practices.

Received: February 25, 2025
Accepted: January 21, 2026

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Keywords

Sustainable exploitation, cultivation, Dao ethnic minority, Ba Vi National Park

Introduction

Medicinal plants are essential to healthcare and rural livelihoods in many developing countries, yet unsustainable exploitation and

habitat degradation have led to significant resource decline. In Vietnam, uncontrolled harvesting has resulted in the decline of 136 medicinal plant species, including 18 classified as critically endangered by the IUCN (Nguyen & Nguyen, 2008). Despite this decline, Vietnam remains a global biodiversity hotspot with more than 5,000 medicinal plant species and subspecies used in traditional and modern medicine (MONRE, 2019), and forest products continue to play a vital role in upland livelihoods (Sunderlin & Huynh, 2005; Sunderlin, 2006; Muller *et al.*, 2006; McElwee, 2008).

Ba Vi National Park harbors over 500 medicinal plant species of high scientific and economic value, including several listed in Vietnam's Red Data Book (Ba Vi National Park, 2023). However, overexploitation and illegal harvesting have led to the decline of many species (Tran Binh Da & Le Quoc Doanh, 2010). In the Park's buffer zone, the Dao people have practiced traditional medicine for more than 50 years, relying on wild-harvested medicinal plants for their livelihoods while maintaining valuable indigenous knowledge of medicinal plant cultivation and use (Tran Binh Da & Le Quoc Doanh, 2010; Hoang Van Sam, 2012). Achieving a balance between livelihood needs and conservation objectives, therefore, remains a key challenge. In recent years, the Vietnamese government has promoted medicinal plant development through national policies, including Decision No. 1719/QĐ-TTg (October 14, 2023) under the National Target Program on Socio-Economic Development in Ethnic Minority and Mountainous Areas (2021-2030) and Decree No. 81/2023/ND-CP (January 9, 2023), both of which emphasize sustainable development and value-chain investment for medicinal plants.

Many previous studies have emphasized the statuses of medicinal plant species in Ba Vi National Park (Tran *et al.*, 2001; Tran Minh Tuan & Vu Anh Tai, 2014; Vu *et al.*, 2023), the indigenous knowledge of medicinal plants among the Dao ethnic group (Tran Binh Da & Le Quoc Doanh, 2010; Hoang Van Sam, 2012), and biodiversity conservation in the area (Nguyen Hai Ha & Nguyen Thi Hai Ninh, 2014). However, few have examined conservation

approaches that promote medicinal plant cultivation at the household level, leading to limited empirical evidence on household practices, opportunities, and constraints. Therefore, this study aimed to assess the potential for household-based conservation of medicinal plants in Ba Vi commune, Hanoi, where the Dao ethnic minority resides in the buffer zone of Ba Vi National Park, by addressing two key questions: (1) What are the current practices of Dao households in exploiting and cultivating medicinal plants? and (2) What are the main opportunities and constraints affecting household-based cultivation?

Study Sites and Methods

Study sites

Ba Vi National Park is located in northern Vietnam, about 50km west of the Hanoi city center, extending from 20°55' to 21°07' N latitude and from 105°18' to 105°30' E longitude (**Figure 1**). Ba Vi National Park was established in 1991. The park covers a total area of 9,702.41 ha and is made up of three zones: a strictly protected zone (1,718.56ha), an ecological rehabilitation zone (7,511.68ha), and a recreation and administration zone (472.17ha). The main vegetation types in Ba Vi are lowland evergreen forest, lower montane evergreen forest, and lower montane mixed coniferous and broadleaf forest. The area of the buffer zone is 43,698.7ha. There is a population of about 127,000 people living there, belonging to four ethnic groups: Kinh (51%), Muong (45.6%), Dao (2.15%), and Thai (0.15%) (Ba Vi National Park, 2023). They collect and process noticeable quantities of medicinal plants daily from the park and its surroundings, both for commercial and domestic purposes.

Ba Vi commune, located in the buffer zone of Ba Vi National Park, is home to the Dao ethnic minority that has long preserved and developed the traditional medicine practice known as southern medicine (Thuoc Nam). The Dao people in Ba Vi are concentrated in the three villages of Yen Son, Hop Nhat, and Hop Son, with more than 550 households and over 2,000 people, accounting for 98% of the commune's

total population (Ba Vi Commune People’s Committee, 2024). The Dao people have a long history of using forest resources (fuelwood, fodder, medicinal plants, etc.) for their livelihoods. Traditional medicine practices have contributed to the livelihoods of the Dao people in Ba Vi commune for over 50 years and also constituted a major economic activity of many Dao households in the study site. While the demand for using medicinal plant raw materials to make traditional medicine products in Ba Vi commune has been increasing, medicinal plants used in traditional medicine have become scarce. The continuous exploitation and usage of medicinal plants without conservation efforts have caused species scarcity, especially for endangered species. For these reasons, the conservation and sustainable use of medicinal plants need to be given priority. In reality, local authorities in Ba Vi commune have been making great efforts to preserve and develop the traditional medicine practices of the Dao people. The Traditional Medicine Association in Ba Vi commune was established in June 1996, and

activities of the association are closely linked to the preservation, development, and processing of traditional medicines. In 2016, the local authorities established the Dao Ethnic Traditional Medicine Service Cooperative, which aims to harvest and effectively conserve rare and high-value medicinal plants.

Methods

To conduct our research, both secondary and primary data were used. Official statistics and legal and policy documents from state offices provided secondary data, while primary data were attained from key informant interviews and household surveys. Secondary data about the statuses of forest resources and medicinal plants, management, and the protection of medicinal plant genetic resources in Ba Vi National Park were collected from the Ba Vi National Park Management Board. An overall background of the geographical and socio-economic conditions of the study site was from the Commune People’s Committee. Key informants from the Ba Vi

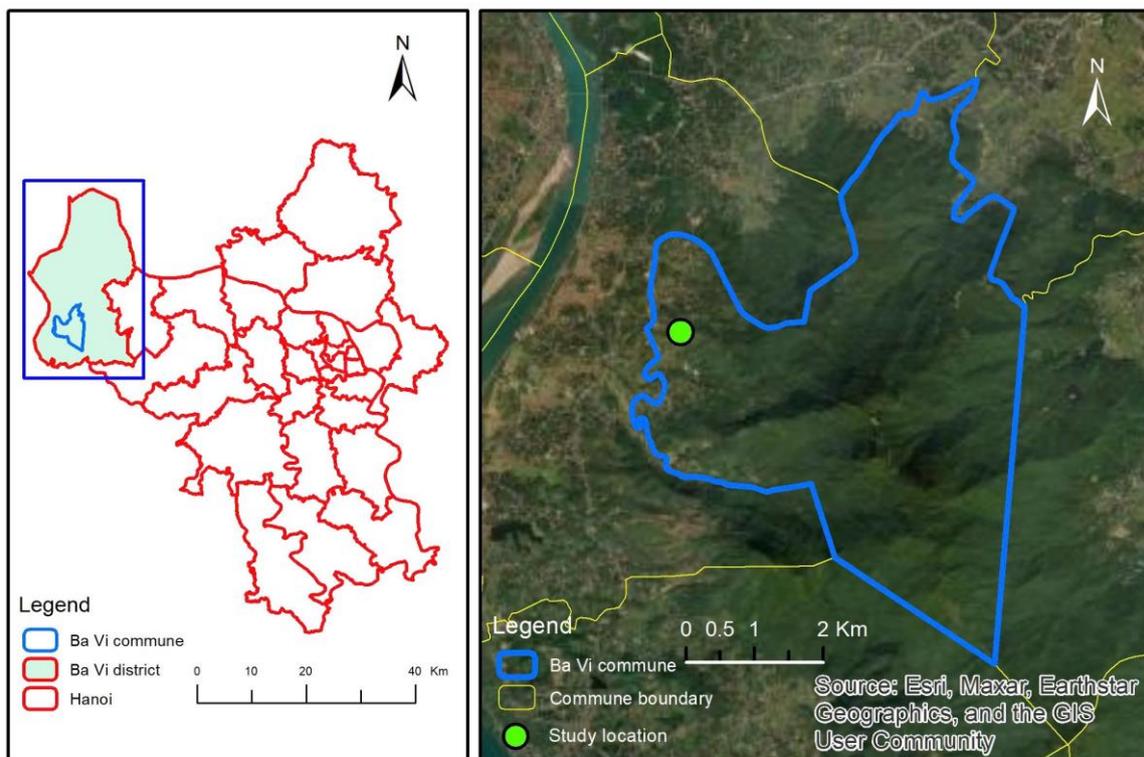


Figure 1. Location of study site

National Park Management Board, the Forest Protection Unit, and elderly people of the villages were interviewed.

Household surveys: Face-to-face interviews with household heads and their spouses using semi-structured questionnaires were conducted in Hop Nhat village and Hop Son village of Ba Vi commune from November to December 2023. The 50 Dao households (25 households per village) were selected using purposive sampling based on the following criteria: (i) households engaged in the production of traditional medicines, and (ii) households with a tradition of exploiting medicinal plants from the forests in Ba Vi National Park. Local authorities and village leaders assisted in identifying households to ensure representation across different levels of cultivation experience and landholding sizes. The sample size of 50 was determined to cover the majority of households actively involved in medicinal plant activities in the two villages, providing sufficient variation in practices while remaining feasible for detailed field surveys. The questions used in this study were about land use activities; exploitation, use, processing, and cultivation of medicinal plants; and advantages and difficulties in the exploitation and cultivation of medicinal plants in the locality. Details of the research focus and indicators used for data collection are summarized in **Table 1**.

Group discussions: Two group discussion sessions were conducted at the study site, with 8-10 Dao participants in each session. The discussions focused on local livelihoods and the harvesting and cultivation of medicinal plants. Qualitative data from the discussions were transcribed, coded, and analyzed using thematic content analysis to identify common themes,

practices, and the participants' perceptions regarding the harvesting and cultivation of medicinal plants.

Data were recorded, coded, and analyzed in Microsoft Excel (version 2019) and IBM SPSS Statistics (version 22). Descriptive statistics, including frequency, percentage, and mean values, were applied in this study.

Results and Discussion

Dependence and exploitation of medicinal plant resources by Dao households in Ba Vi National Park

Despite strict legal prohibitions of the Law on Forestry (2017) and the Law on Biodiversity (20/2008/QH12) against the exploitation of forest resources in the core zone of Ba Vi National Park, the survey revealed that 40% of the interviewed households admitted to collecting medicinal plants from these protected areas (**Figure 2**). The Dao households in Ba Vi commune have exploited over 200 medicinal plant species for treating different diseases. The findings indicate that the Dao households living in the buffer zone of Ba Vi National Park still depend heavily on the park's medicinal plant resources for their livelihoods. These species are frequently selected and used in the production of traditional medicines by the Dao households due to their pharmacological values.

Among the Dao households who reported collecting medicinal plants from the core zone of Ba Vi National Park, forest access remained frequent (**Table 2**). About 45% of these households entered the forest several times a week, while 40% did so weekly; only 10% went monthly, and 5% rarely accessed the forest.

Table 1. Research focus and corresponding indicators

Research focus	Indicators
Dependence and exploitation of medicinal plants	<ul style="list-style-type: none"> - Households collecting from protected areas - Frequency of forest access for collecting medicinal plants - Use of threatened species
Household-based conservation of medicinal plants	<ul style="list-style-type: none"> - Land area used for medicinal plant cultivation - Cultivated medicinal plant species - Participation in training programs - Perceived advantages and challenges in the cultivation and development of medicinal plants

These findings suggest that most of the households engaged in collecting medicinal plants maintain regular contact with forest areas, reflecting a high level of dependence on forest resources for their traditional medicine practices.

In addition, several medicinal plants collected by the Dao households living in the buffer zone of Ba Vi National Park are listed in Vietnam’s Red Data Book (2007), including four threatened species: one endangered (EN) species and three vulnerable (VU) species, namely *Drynaria fortunei* (Kuntze ex Mett.) J. Smith (EN), *Stephania dielsiana* C.Y. Wu (VU), *Ardisia silvestris* Pitard (VU), and *Asarum glabrum* Merr. (VU) (Table 3). The interviews revealed that most households were aware that collecting plants from the core zone is legally prohibited under the Law on Forestry (2017), yet they continued doing so due to livelihood dependence and the increasing demand for medicinal raw materials. The continued harvesting of these threatened species by the Dao

households may lead to further population declines and pose a serious risk to their long-term survival in the park. The growing demand for raw materials for traditional medicine production in Ba Vi commune has consequently placed high pressure on the genetic resources of medicinal plants in Ba Vi National Park. This situation highlights the urgent need for household-based conservation measures and alternative livelihood options to ensure both biodiversity protection and sustainable resource use among Dao communities.

Household-based conservation of medicinal plants in the buffer zone of Ba Vi National Park

In Vietnam, collecting and exploiting medicinal plants freely from natural forest ecosystems has been banned by the current legal framework (Law on Forestry, 2017). In addition, medicinal plant resources from surrounding natural forest ecosystems have become increasingly scarce. As a result, the cultivation of medicinal plants could be a viable alternative to

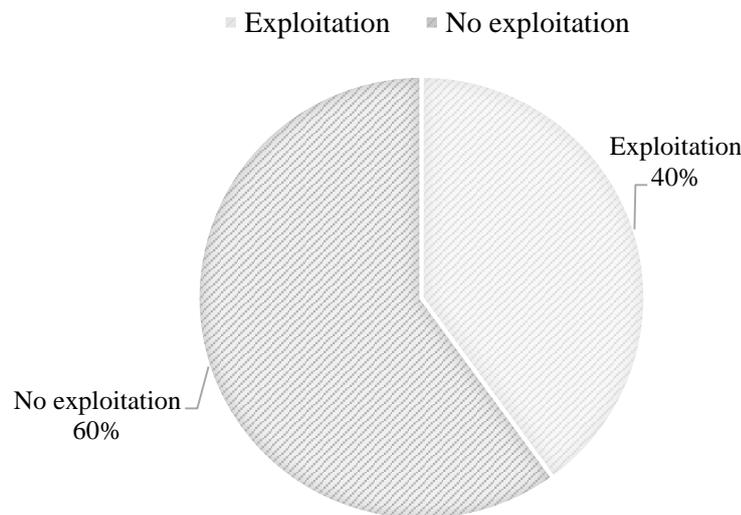


Figure 2. Percentage of interviewed households exploiting medicinal plants in the core zone of Ba Vi National Park

Table 2. Frequency of forest access for collecting medicinal plants by Dao households

Frequency of accessing the forest*	Percentage of households (%)
Several times a week	45
Weekly	40
Monthly	10
Rarely	5

Note: *Refers to the sampled households who collect forest medicinal plants in the core zone of Ba Vi National Park.

Table 3. Exploitation of endangered, rare species from Ba Vi National Park by Dao households

No.	Scientific name	Local name/ common name	Part of plant used	Diseases plants treat	Endangered species in Vietnam's Red Data Book
1	<i>Drynaria fortunei</i> (Kuntze ex Mett.) J. Smith	Cốt toái bổ	Stems, leaves	Tonic, asthma	EN A1,c,d
2	<i>Stephania dielsiana</i> C. Y. Wu	Củ dôm	Root	Stomach pains, stomachache, menstrual pain	VU B1+2b,c
3	<i>Ardisia silvestris</i> Pitard	Lá khô	Leaves, roots	Stomach pains	VU A1a,c,d+2d
4	<i>Asarum glabrum</i> Merr.	Hoa tiên	Roots, leaves	Digestive diseases, anti- inflammatory, pain relief	VU A1c,d

Note: EN: Endangered, VU: Vulnerable

maintaining the traditional medicine profession of the Dao people in Ba Vi commune and would also be considered a tool for biodiversity conservation. In particular, promoting the cultivation of medicinal plants in home gardens and agroforestry models, instead of collecting them from the forest, could help reduce pressure on wild medicinal plants while sustaining household livelihoods.

Land use of Dao households

Since the early 2010s, the Dao households in Ba Vi commune have been interested in the cultivation of medicinal plants in their gardens and farming lands. In recent years, more and more Dao households have participated in cultivating medicinal plants as the demand for raw materials for traditional medicine has risen noticeably following the depletion and scarcity of medicinal plants from surrounding natural forests. The mean farmland area per sampled Dao household was 0.56ha. It was estimated that the land area used for medicinal plants by the Dao households made up 31.30% of the total farmland area. There was a large disparity among the land area used for medicinal plants of the Dao households in Ba Vi commune; the maximum area per household was 1.5 ha, the minimum area per household was only 0.003ha, and the mean of the area used for medicinal plants per sampled Dao household was 0.2ha (**Table 4**).

These findings revealed that the medicinal plant cultivation areas of Dao households are small and fragmented. There is a considerable disparity among the medicinal plant cultivation

areas of Dao households. Households that had a medicinal plant cultivation area of less than 0.1ha comprised 72% of the total sampled households (36 of 50 households). Ten households had a medicinal plant cultivation area of 0.1-1ha, making up 20%. There were only four households (8%) that had a medicinal plant cultivation area of more than 1ha (**Table 4**).

Cultivation and development status of medicinal plants of Dao households in Ba Vi commune

At the study site, most of the medicinal plant species selected for cultivation by the Dao households correspond to a list of the species that were exploited in Ba Vi National Park. The survey showed that 37 main species appeared in the farmlands of over 50% of the sampled households (**Table 5**), and they are widely used for treating different diseases. The Dao households in Ba Vi commune cultivated these medicinal plants for the principal reason of making their medicinal products. There were several species cultivated for both use as a material and for conservation, namely *Drynaria fortunei* (Kuntze ex Mett.) J. Smith, *Stephania dielsiana* C. Y. Wu, *Ardisia silvestris* Pitard, *Asarum glabrum* Merr., *Croton tonkinensis* Gagnep, and *Reynoutria japonica* Houtt.

This study revealed that some precious, rare, and endangered medicinal plant species listed in Vietnam's Red Data Book were cultivated and developed in the farmlands of the Dao households in Ba Vi commune. If this activity continues to be maintained and supported, it could significantly

Table 4. Farmland area and medicinal plant cultivation area of Dao households, and distribution of households by cultivation area (2023)

<i>(A) Farmland area and medicinal plant cultivation area per household</i>		
Indicator	Farmland (ha) (n = 50)	Land used for cultivating medicinal plants (ha) (n = 50)
Mean	0.56	0.20
Max	5	1.5
Min	0.02	0.003
<i>(B) Number of households cultivating medicinal plants</i>		
Cultivation area category (ha)	Number of households	Percentage of sample (%)
> 1.0	4	8
0.1-1.0	10	20
< 1.0	36	72

contribute to the conservation of medicinal plant resources while improving the livelihoods of the Dao households practicing traditional medicine at the study site. The findings also indicated that the parts of the medicinal plants used by the Dao households for treating diseases are diverse, depending on the intended purpose, and include fruits, leaves, flowers, seeds, stems, branches, roots, tubers, rhizomes, and whole plants. Traditional medicinal products produced by the Dao households in Ba Vi commune focus on treating various ailments and conditions such as heat-clearing and detoxifying, liver troubles, bone and joint diseases, stomach pains, and digestive disorders (**Table 5**).

The findings from this study reveal a clear potential for developing household-based conservation models among Dao households. Their accumulated traditional knowledge, practical experience in cultivating medicinal plants, and strong cultural attachment to traditional medicine form an important foundation for sustainable management of medicinal plant resources. Although current cultivation activities are still small in scale, they demonstrate the households' readiness to participate in conservation initiatives when technical guidance and market access are available. Promoting household-based conservation would not only strengthen the local conservation network but also create incentives for maintaining traditional medicinal practices while reducing the pressure on wild plant populations in Ba Vi National Park. Therefore,

integrating these cultivation efforts into community-based conservation and livelihood improvement programs should be a strategic direction for future interventions.

Training about the exploitation and cultivation of medicinal plants of Dao people in Ba Vi commune

The findings indicated that the exploitation and cultivation activities of medicinal plants by the Dao people in Ba Vi commune were primarily based on conventional experience inherited from their ancestors, receiving information shared from other farmers, or visiting medicinal plant cultivation models. Specifically, only 25% of the respondents participated in training on the exploitation and cultivation of medicinal plants, and 75% of the respondents had not yet joined any training courses (**Figure 3**). The training activities mainly focused on sharing experiences and enhancing technical knowledge related to the cultivation, harvesting, preservation, and processing of traditional medicinal plants. The training emphasized sustainable resource use through the introduction of improved cultivation techniques and appropriate harvesting methods, particularly avoiding the uprooting of whole plants to allow natural regeneration and ensure the long-term availability of medicinal resources. Participants also exchanged local experiences and practical skills, which contributed to raising awareness of sustainable use and the conservation of medicinal plant resources.

Table 5. List of medicinal plant species cultivated by Dao households in Ba Vi commune

No.	Scientific name	Local name/ common name	Part of plant used	Diseases and conditions the plant treats
1	<i>Helicteres hirsuta</i> Lour.	An xoa	Leaves	Liver troubles
2	<i>Hedyotis diffusa</i> Willd.	Bạch hoa xà thiệt thảo	Whole plant	Heat-clearing, detoxifying
3	<i>Glycosmis citrifolia</i> (Willd.) Lindl.	Bưởi bung	Leaves, fruits	Cough, cold
4	<i>Solanum procumbens</i> Lour.	Cà gai leo	Vines, leaves, fruits	Heat-clearing, liver troubles
5	<i>Excoecaria cochinchinensis</i> Lour.	Đơn lá đỏ	Leaves	Skin rashes
6	<i>Homalomena aromatica</i> (Roxb)	Thiên niên kiện	Rhizomes	Rheumatism, infection
7	<i>Gnetum montanum</i> M.	Gắm	Whole plant	Bone and joint diseases
8	<i>Drynaria fortunei</i> (Kuntze ex Mett.) J. Smith (+)	Cốt toái bổ	Stems, leaves	Tonic
9	<i>Fallopia multiflora</i> (Thunb.) Haraldson	Hà thủ ô	Tubers	Nourishes the liver and kidneys
10	<i>Stahlianthus thorelii</i> Gagnep	Tam thất gừng	Roots	Stomach ache, blood nourishing
11	<i>Callisia fragrans</i> (Lindl.) Woodson	Lược vàng	Stems, leaves	Heat-clearing, detoxifying
12	<i>Glycosmis cyanocarpa</i> (Bl.) Spr.	Chánh chó	Stems	Stomachache, cough, snake bites
13	<i>Jasminum subtriplinerve</i> Bl.	Chè vằng	Leaves	Heat-clearing, detoxifying, postpartum care
14	<i>Abutilon indicum</i> (L.) Sweet.	Cối xay	Leaves, seeds	Heat-clearing, detoxifying, fever, cold
15	<i>Stephania dielsiana</i> C. Y. Wu (++)	Củ dỏm	Roots	Headache, bone and joint diseases
16	<i>Dioscorea cirrhosa</i> Lour.	Củ nâu	Leaves	Indigestion
18	<i>Hedyotis capitellata</i> Wall. ex G. Don.	Dạ cẩm	Stems, leaves	Stomach pains, digestive diseases, detoxifying
19	<i>Mussaenda pubescens</i> Ait f.	Bướm bạc	Whole plant	Asthma, rheumatoid arthritis
20	<i>Polyscias fruticosa</i> (L.) Harms	Đình lăng	Whole plant	Tonic, postpartum care
21	<i>Tinospora sinensis</i> (L.) Merr.	Dây đau xương	Vines	Rheumatoid arthritis
22	<i>Kaempferia galanga</i> L.	Địa liên	Roots	Bone and joint diseases
23	<i>Sargentodoxa cuneata</i> (Oliv.) Rehd. et Wiis	Huyết đằng	Stems	Backache, bone and joint diseases
24	<i>Cordyline fruticosa</i> (L.) A. Chev	Huyết dụ	Leaves	Blood nourishing
25	<i>Vernonia amygdalina</i> Delile.	Mật gấu	Stems, roots, leaves	Digestive disorders, diabetes
26	<i>Eurycoma longifolia</i> Jack	Mật nhân	Whole plant	Dysentery, menstrual disorders, male physiological weakness
27	<i>Flagellaria indica</i> L.	Mây dốc	Stems, leaves, flowers	Indigestion
28	<i>Curcuma zedoaria</i> (Berg.) Roscoe	Nghệ đen	Roots	Stomach pains
29	<i>Oroxylum indicum</i> (L.) Kurz.	Núc nác	Stems	Arthritis
30	<i>Ardisia silvestris</i> Pitard (+++)	Lá khô	Leaves	Stomach pains

No.	Scientific name	Local name/ common name	Part of plant used	Diseases and conditions the plant treats
31	<i>Croton tonkinensis</i> Gagnep	Khổ sâm	Stems, leaves	Stomach and duodenal ulcers, malaria, stomach pains
32	<i>Gynostemma pentaphyllum</i> (Thunb.) Makino	Giảo cổ lam	Leaves, branches	Fatty blood
33	<i>Celastrus hindsii</i> Benth.	Xạ đen	Stems, branches, leaves	Digestive aid
34	<i>Asarum glabrum</i> Merr. (++++)	Hoa tiên	Roots, leaves	Digestive diseases, anti- inflammatory, pain relief
35	<i>Reynoutria japonica</i> Houtt.	Cốt khí	Stems, leaves, roots	High blood pressure, bloating
36	<i>Tradescantia zebrina</i> Hort. Ex Loudon	Thài lài tía	Leaves	Constipation
37	<i>Gardenia jasminoides</i> Ellis	Dành dành	Fruits	Diabetes, urinary tract infection

Note: (+), (++) , (+++) , and (++++) indicate the conservation status of the species listed in the table according to Vietnam's Red Data Book (2007): (+) EN A1,c,d; (++) VU B1+2b,c; (+++) VU A1a,c,d+2d; (++++) VU A1c,d.

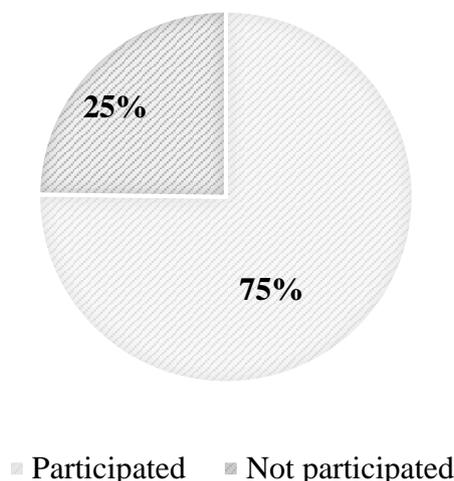


Figure 3. Percentage of the respondents who had participated in training about the exploitation and cultivation of medicinal plants

Advantages and disadvantages of cultivation and development of medicinal plants in Ba Vi commune

The results of the group discussions about the advantages and disadvantages of cultivation and development of medicinal plants in Ba Vi commune are summarized in **Table 6**.

(i) Advantages of cultivation and development of medicinal plants in Ba Vi commune

Group discussions with the Dao households in Ba Vi commune indicated that the Dao people have extensive experience in cultivating, harvesting, and utilizing medicinal plants, with

most having practiced these activities for over 20 years. Their indigenous knowledge related to the collection, processing, and use of medicinal plants is fundamental to maintaining and developing traditional medicine in the area, as also highlighted in previous studies (Tran *et al.*, 2001; Tran Binh Da & Le Quoc Doanh, 2010; Hoang Van Sam, 2012). This knowledge encompasses plant identification, processing, and applications, as well as practical propagation skills, including determining suitable periods for seed collection, seedling propagation, transplanting wild seedlings, rhizome cutting, plant division, and plant care. Their accurate

Table 6. Advantages and disadvantages of cultivation and development of medicinal plants in Ba Vi commune

Advantages	Disadvantages
<p>Dao people have experience in cultivating, exploiting, and utilizing medicinal plants.</p> <p>Traditional medicine practices of the Dao people are recognized as a traditional medicine village.</p> <p>The climate conditions are suitable for the survival and growth of medicinal plants.</p>	<p>Lack of arable land to expand areas of medicinal plants.</p> <p>Lack of suitable plant varieties.</p> <p>Lack of cultivation techniques.</p>

understanding of planting seasons reflects an empirical awareness of plant growth that supports healthy development and high yields. When integrated with modern propagation methods, such traditional knowledge plays an essential role in conserving and sustainably utilizing valuable medicinal plant resources.

Another advantage of the development of medicinal plants in Ba Vi commune is that the traditional medicine practices of the Dao people are recognized as a traditional medicine village. This has led to Dao households being encouraged to cultivate medicinal plants. In addition, the interviewed Dao people in Ba Vi commune admitted that the climate conditions are suitable for cultivating many medicinal plants.

(ii) Disadvantages of cultivation and development of medicinal plants in Ba Vi commune

As indicated in **Table 4**, the area used for medicinal plants on average per sampled Dao household was 0.2ha. The Dao households claimed that the lack of arable land has been one of the biggest barriers to expanding the areas where medicinal plants are grown in the study site. Besides, the lack of suitable plant varieties and cultivation techniques have been considered obstacles to the expansion of medicinal plant cultivation areas in the buffer zone of Ba Vi National Park.

Overall, while the Dao households possess strong indigenous knowledge, favorable climatic conditions, and cultural motivation to cultivate medicinal plants, limitations in land area, cultivation techniques, and access to quality planting materials still constrain large-scale development. Nevertheless, these strengths and long-standing experiences provide a solid foundation for developing effective household-

based conservation and promoting the sustainable use of medicinal plant resources in the future. The household-based approach offers great potential for conservation because Dao households already maintain small home gardens and forest-edge plots where medicinal plants are cultivated for both household use and income generation. By expanding these household-level systems, local people can contribute to the ex-situ conservation of valuable species while reducing harvesting pressure on natural populations inside Ba Vi National Park. To realize this potential, supportive interventions are needed to strengthen the technical capacity, ensure access to suitable land and planting materials, and connect local producers with stable markets. If these enabling conditions are met, Dao households could become key actors in conserving medicinal plant diversity, sustaining traditional medicine practices, and improving their livelihoods in a mutually reinforcing way.

Conclusions

The Dao households in the Ba Vi buffer zone continue to rely on medicinal plants from the park for traditional medicine, often threatening natural populations. Four of these frequently used species are listed in Vietnam's Red Data Book, highlighting the need for sustainable use and management to support both biodiversity and local livelihoods.

At the study site, ex-situ conservation strategies have been applied, including integrating medicinal plants into farmlands and home gardens to support sustainable use and conservation. Nevertheless, the areas under cultivation by the Dao households remain small. Expansion is constrained by limited arable land, access to suitable plant varieties, and cultivation techniques.

Medicine production is considered a major economic activity of Dao households in Ba Vi commune, but the medicinal plant raw materials needed for their traditional medicine production, which have been exploited from the areas of cultivation by Dao households, have been restricted. Based on the empirical findings, the establishment and development of medicinal plant cultivation under the forest canopy may be considered a potential option, with the aim of contributing to livelihood support for the Dao households in Ba Vi commune while potentially alleviating pressure on natural forests. In addition, community nurseries focusing on several priority medicinal species should be established to ensure sustainable seedling supply. It is also important to preserve and promote Dao indigenous knowledge related to the collection, cultivation, and use of medicinal plants as part of long-term conservation and livelihood strategies.

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