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Medicinal Plant Resources and Cultivation in Vietnam: Current Status, Challenges, and Development Perspectives

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ABSTRACT: Vietnam possesses abundant medicinal plant resources, with 5,117 species belonging to approximately 1,823 genera and 362 families documented to date. Its diverse ecological conditions offer considerable potential for developing medicinal plant cultivation areas. This review systematically examines the diversity, distribution, chemical constituents, and biological activities of selected medicinal plants with high economic value. It also evaluates the current status, benefits, opportunities, and challenges of medicinal plant cultivation in Vietnam. Under the national medicinal plant development plan, 54 priority species have been designated for cultivation across eight ecological regions, based on ecological suitability and regional advantages. The total area allocated to medicinal plant development has been reported at approximately 357,178 ha, with cultivation concentrated mainly in the northern mountainous regions. Developing medicinal plant cultivation areas can secure raw material supplies, improve local livelihoods, increase economic value, and reduce harvesting pressure on wild populations. However, cultivation remains fragmented, with limited standardization, insufficient integration across the value chain, and inadequate advanced processing capacity. Future development should prioritize specialized cultivation areas supported by standardized production practices, traceability systems, and coordinated management of genetic resources, planting materials, ecological suitability, cultivation, quality control, processing, and market access. These strategies are essential for improving the economic value, competitiveness, and long term sustainability of Vietnam's medicinal plant sector.

KEYWORDS: Medicinal plants; medicinal plant cultivation areas; medicinal raw materials; high-value medicinal plants; Vietnam.

1. Introduction

Vietnam is recognized as one of the world's most biodiverse countries, with exceptionally rich plant diversity and medicinal plant resources [1, 2]. This remarkable biological diversity,

together with a long history of traditional plant use, has made Vietnam an important reservoir of medicinal plant resources with considerable potential for natural-product and drug discovery [3, 4]. Traditional medicine remains an important component of healthcare in many low- and middle-income countries, and WHO reports have highlighted the extensive reliance on traditional and herbal medicines for primary healthcare in many populations [5−7]. In Vietnam, medicinal plants have long been used in traditional medicine and local healthcare practices, reflecting both the country's biological diversity and its rich ethnomedicinal knowledge [2, 8]. Recent inventories indicate that 5,117 plant species used medicinally, belonging to approximately 1,823 genera and 362 families, have been documented in Vietnam [9], underscoring the substantial potential of the country's medicinal plant resources for pharmaceutical research, drug development, and healthcare applications.

Medicinal plants also represent economically valuable biological resources with the potential to contribute to livelihood diversification, biodiversity conservation, and the sustainable supply of raw materials for the pharmaceutical and herbal medicine industries [10−12]. However, continued reliance on wild harvesting may increase pressure on natural medicinal plant populations, particularly rare, threatened, and economically valuable species [13, 14]. Therefore, the transition from wild harvesting toward conservation integrated with the development of controlled cultivation areas is important for securing raw-material supplies, reducing pressure on natural resources, and improving the consistency, uniformity, and traceability of medicinal materials. Accordingly, the development of specialized cultivation areas, combined with control of planting materials, cultivation practices, raw-material quality, primary processing, advanced processing, and market linkages, represents an important pathway for transforming medicinal plant resources into standardized, high-value medicinal raw materials [15, 16].

In this context, a comprehensive assessment of medicinal plant resources together with the current status of cultivation-area development, associated benefits, advantages, and existing constraints is essential for identifying appropriate development strategies for Vietnam. Such an assessment is particularly important because the considerable diversity of medicinal plant resources does not automatically translate into sustainable and high-value raw-material production. The development of cultivation areas requires the identification of suitable species and production regions, together with consideration of planting materials, ecological requirements, raw-material quality, production scale, processing capacity, and market demand. Vietnam also has important ecological advantages for developing specialized medicinal plant cultivation areas. Pronounced regional differences in topography, elevation, temperature, precipitation, and soil characteristics create diverse ecological conditions suitable for medicinal plants with different ecological requirements. This ecological differentiation provides opportunities to match particular medicinal plant species with suitable production regions and geographical origins, thereby supporting the development of specialized cultivation areas for high-value medicinal raw materials. Accordingly, this review aims to (i) synthesize current knowledge on the diversity, distribution, chemical constituents, and biological activities of selected high-value medicinal plants in Vietnam; (ii) analyze the current status and the economic, social, conservation, and raw-material supply benefits associated with medicinal plant cultivation; and (iii) evaluate the major advantages and challenges and propose development directions for standardized, traceable, and high-value medicinal raw-material production areas in Vietnam.

2. High-Value Medicinal Plant Resources in Vietnam

2.1. Diversity of Medicinal Plant Species.

Vietnam possesses highly diverse indigenous medicinal plant resources, providing a strong foundation for selecting species adapted to different ecological regions and for developing high-value medicinal products. Field surveys conducted across the country have demonstrated the considerable richness of these resources. In Phieng Pan Commune, Son La Province, 362 medicinal plant species belonging to 269 genera and 110 families were documented, while a survey in Tan Phu Protection Forest, Dong Nai Province, recorded 351 plant species with medicinal uses. Similarly, an ethnobotanical study among the Tay ethnic community in Thai Nguyen Province identified 321 medicinal plant species belonging to 253 genera and 103 families [17, 18]. At a broader geographical scale, Bui et al. (2024) documented 922 medicinal flowering plant species belonging to 600 genera and 140 families that are distributed in both Vietnam and Indonesia, further highlighting the substantial diversity of Vietnam's medicinal plant resources [18].

Many rare and valuable medicinal plant species with considerable economic potential occur naturally in Vietnam's forest ecosystems, including *Panax vietnamensis* (Ngoc Linh ginseng), *Panax bipinnatifidus* (Vu Diep ginseng), *Panax stipuleanatus* (wild Panax), *Lilium brownii* (Bach Hop), *Taxus* spp. (yew), *Coscinium fenestratum* (Vang Dang), *Mahonia* spp. (Hoang Lien O Ro), *Berberis* spp. (Hoang Lien Gai), *Nervilia* spp. (Thanh Thien Quy), and *Anoectochilus* spp. [19]. These species represent important biological resources because of their medicinal, economic, and conservation significance. In addition, the Vietnamese Ministry of Health has established an official list of 23 precious, rare, and endemic medicinal species or medicinal-material groups subject to specific management and control [20]. Among these species, several have been investigated for cultivation and domestication as a means of reducing dependence on wild harvesting while simultaneously developing sustainable sources of high-value medicinal raw materials.

The distribution of high-value medicinal plants in Vietnam is strongly associated with the country's diverse topography, climatic gradients, and forest ecosystems. Many economically important species are concentrated in mountainous and forested regions of northern and central Vietnam and the Central Highlands, where variations in altitude, temperature, humidity, soil properties, and forest-canopy cover create distinct ecological niches. Several species exhibit relatively restricted natural distributions. For example, *P. vietnamensis* is naturally distributed mainly in the Ngoc Linh mountain range of Quang Nam and Kon Tum provinces, whereas *P. vietnamensis* var. *fuscidiscus* is associated with high-elevation habitats in Lai Chau Province [21, 22]. Other medicinal plants have broader geographical ranges: *Codonopsis javanica* occurs in mountainous regions of northern Vietnam as well as parts of the Central Highlands, while populations of *Fallopia multiflora* have been documented in several northern mountainous provinces, including Lao Cai, Ha Giang, and Son La [23−25]. Jewel orchids such as *Anoectochilus roxburghii* are typically associated with humid and shaded forest habitats with relatively high canopy cover. These heterogeneous distribution patterns highlight the close relationship between medicinal plant resources and local ecological conditions and indicate that the establishment of cultivation areas should consider species-specific ecological requirements, geographical provenance, and genetic resources.

2.2. Chemical Constituents and Biological Activities.

Previous studies have demonstrated that medicinal plants of high economic value in Vietnam contain diverse bioactive compounds, including saponins, flavonoids, polysaccharides, anthraquinones, phenylpropanoids, terpenoids, and phenolic compounds. These constituents have been investigated for various biological activities, including antioxidant, anti-inflammatory, immunomodulatory, neuroprotective, antimicrobial, metabolic regulatory, and antiproliferative effects. Table 1 summarizes the major bioactive constituents and reported biological activities of selected medicinal plant species in Vietnam, highlighting their potential applications in pharmaceutical and medicinal product development.

Table 1. Major Constituents and Biological Activities of Selected High-Value Medicinal Plants in Vietnam.

Medicinal plant species	Major bioactive constituents	Biological activities	References
Panax vietnamensis	Ginsenosides, dammarane- and ocotillol-type saponins, flavonoids, phenolic compounds	Anti-inflammatory, anti-stress, neuroprotective, antiproliferative, and antitumor activities	[26, 27]
P. vietnamensis var. fuscidiscus	Saponins, ginsenosides	Rich saponin profile; substantial similarity to P. vietnamensis var. vietnamensis, with distinct chemical characteristics	[22, 28]
Anoectochilus roxburghii	Kinsenoside, flavonoids, polysaccharides, and glycosides	Antioxidant, anti-inflammatory, immunomodulatory, and metabolic regulatory activities	[29-31]
Paris polyphylla	Steroidal saponins, including polyphyllins I, II, VI, and VII, and Paris saponins	Antiproliferative, cytotoxic against cancer cells, anti-inflammatory, antibacterial, antifungal, and hemostatic activities	[32, 33]
Fallopia multiflora	Tetrahydroxystilbene glucoside (THSG), emodin, physcion, and other anthraquinones	Antioxidant and lipid metabolism-regulatory activities; hepatoprotective effects in experimental models, but also associated with potential hepatotoxicity	[40, 41]
Gynostemma pentaphyllum	Gypenosides/saponins and flavonoids	Lipid-lowering, anti-inflammatory, antioxidant, cardioprotective, neuroprotective, and glucose metabolism-regulatory activities	[34, 35]
Cinnamomum cassia	Cinnamaldehyde, phenylpropanoids, terpenoids, and polyphenols	Antimicrobial, anti-inflammatory, antioxidant, and glucose- and lipid metabolism-regulatory activities	[36, 37]
Illicium verum	trans-Anethole, essential oils, phenolic compounds, and shikimic acid	Antibacterial, antifungal, antioxidant, anti-inflammatory, and analgesic activities	[38, 39]

Among these species, Panax vietnamensis has received considerable research attention because of its distinctive saponin composition and pharmacological potential. Its ginsenosides and dammarane and ocotillol type saponins have demonstrated potential adaptogenic, antistress, anti-inflammatory, neuroprotective, and antitumor activities, although most supporting evidence originates from preclinical investigations [26]. Numerous ginsenosides have also been isolated from the leaves, suggesting that aerial plant parts may provide additional sources of bioactive compounds beyond the traditionally utilized rhizomes [27]. Phytochemical and metabolomic investigations of P. vietnamensis var. fuscidiscus have revealed a saponin profile broadly comparable to that of P. vietnamensis var. vietnamensis, while identifying distinct chemical characteristics that may support botanical authentication and differentiation [22, 28].

Other medicinal plants exhibit similarly diverse biological activities. As presented in Table 1, Anoectochilus roxburghii contains kinsenoside, polysaccharides, flavonoids, and glycosides, which have been associated with antioxidant, anti-inflammatory, immunomodulatory, and metabolic regulatory effects [29–31]. Paris polyphylla contains

steroidal saponins, particularly polyphyllins, that have demonstrated antiproliferative, anti-inflammatory, antimicrobial, and hemostatic activities in experimental studies [32, 33]. Similarly, gypenosides from Gynostemma pentaphyllum have been investigated for their potential roles in regulating glucose and lipid metabolism, reducing oxidative stress, and providing cardiovascular and neurological protection [34, 35]. The bioactive constituents of Cinnamomum cassia and Illicium verum, particularly cinnamaldehyde and trans-anethole, have also demonstrated antioxidant, anti-inflammatory, and antimicrobial activities [36–39].

Despite these promising findings, the pharmacological potential of medicinal plants must be evaluated alongside their safety profiles and the quality of available evidence. For example, Fallopia multiflora contains tetrahydroxystilbene glucoside (THSG), emodin, physcion, and other anthraquinones associated with antioxidant and metabolic regulatory activities. Although certain experimental studies have reported hepatoprotective effects, cases of liver injury in humans have raised substantial safety concerns [40, 41]. These findings emphasize the importance of standardized cultivation, appropriate processing, chemical characterization, toxicological evaluation, and dosage control. Overall, the evidence summarized in Table 1 indicates that Vietnam possesses considerable medicinal plant resources with potential pharmaceutical applications. However, further clinical validation, safety assessment, and quality standardization are essential before their reported biological activities can be translated into reliable therapeutic products.

3. Current Status of Medicinal Plant Cultivation in Vietnam

Vietnam has prioritized the development of 54 key medicinal plant species across eight ecological regions to establish concentrated cultivation areas based on ecological suitability, regional advantages, and market demand. The planned cultivation areas for the high altitude, mid altitude, and northern midland and mountainous regions are approximately 2,550, 3,150, and 4,600 ha, respectively, with priority species including artichoke, Angelica sinensis, Codonopsis javanica, Morinda officinalis, and Rehmannia glutinosa. The Red River Delta has the largest planned cultivation area, covering approximately 6,400 ha for 20 medicinal plant species. Meanwhile, the North Central and South Central regions have been allocated approximately 3,300 and 3,200 ha, respectively, with priority species including M. officinalis, Polyscias fruticosa, turmeric, Ngoc Linh ginseng (Panax vietnamensis), and Amomum spp. The Central Highlands are expected to develop approximately 2,000 ha, particularly for economically valuable native species such as C. javanica and P. vietnamensis. In addition, approximately 3,000 ha have been designated for Southwestern and Southeastern Vietnam, focusing on medicinal plants such as Melaleuca spp., Andrographis paniculata, and Crinum latifolium [42].

The reported total area associated with medicinal plant development in Vietnam is approximately 357,178 ha, although its distribution varies considerably among ecological regions. As illustrated in Figure 1, the Northeast accounts for the largest area, covering approximately 270,565 ha and encompassing 59 major medicinal plant species, followed by the Northwest, with 46,181 ha and 57 species. The South Central region and Central Highlands account for approximately 15,498 and 13,330 ha, respectively, while the North Central region covers approximately 7,400 ha. In contrast, considerably smaller areas are reported in the Mekong Delta (1,945 ha), Red River Delta (1,214 ha), and Southeast (1,045 ha). This uneven distribution highlights the concentration of medicinal plant resources in northern mountainous

regions, where favorable climatic conditions, diverse elevations, and suitable ecological characteristics support the development of numerous medicinal plant species. However, differences in cultivation area, infrastructure, and regional production capacity indicate the need for regionally tailored development strategies to improve productivity, resource utilization, and supply chain integration.

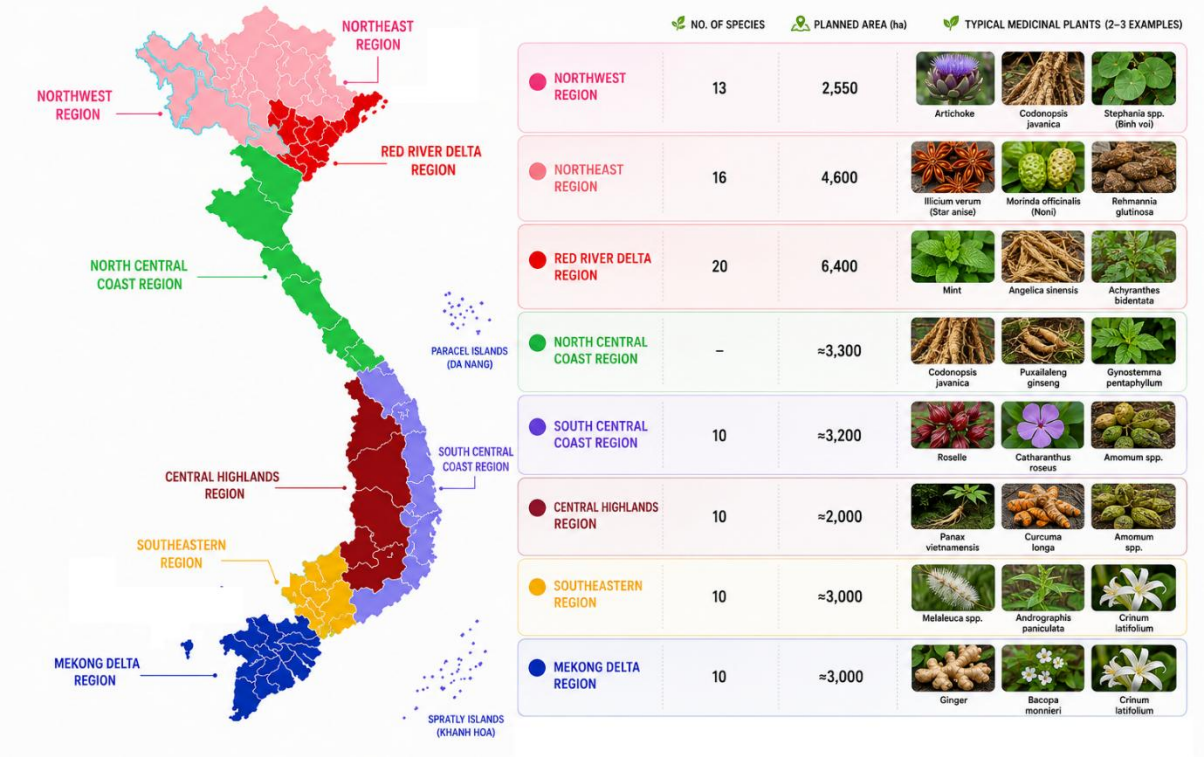


Figure 1. Distribution of Medicinal Plant Cultivation Regions in Vietnam.

4. Benefits of Medicinal Plant Cultivation in Vietnam

Medicinal plant cultivation provides opportunities for livelihood diversification and crop restructuring, particularly in mountainous areas, forest buffer zones, and regions where some conventional crops generate relatively low economic returns. A study conducted in Hoa Binh Province showed that medicinal plant cultivation has the potential to improve household income, with selling prices, input costs, transportation conditions, and market linkages being important determinants of farmers' income [43]. More broadly, medicinal plants are increasingly recognized as high-value crops that can provide opportunities for income generation and rural economic development, particularly when cultivation is linked to commercialization and stable markets [44]. In Vietnam, available evidence also indicates that medicinal plant cultivation can achieve considerably higher economic returns than several conventional agricultural crops, supporting its potential role in agricultural diversification and crop restructuring. The profits from Japanese honeysuckle, *Gymnema sylvestre*, and *Solanum procumbens* were approximately VND 1,340, 352, and 211 million/ha/year, respectively, whereas rice–maize and double-cropping rice systems generated only about VND 51 and 37 million/ha/year, respectively. Evidence from other production models also indicates that medicinal plant cultivation can generate substantially higher income than food crops and several other conventional crops (Figure 2). Therefore, medicinal plants represent a potentially

valuable option for crop restructuring in areas with suitable ecological conditions, appropriate production technologies, and reliable market opportunities.

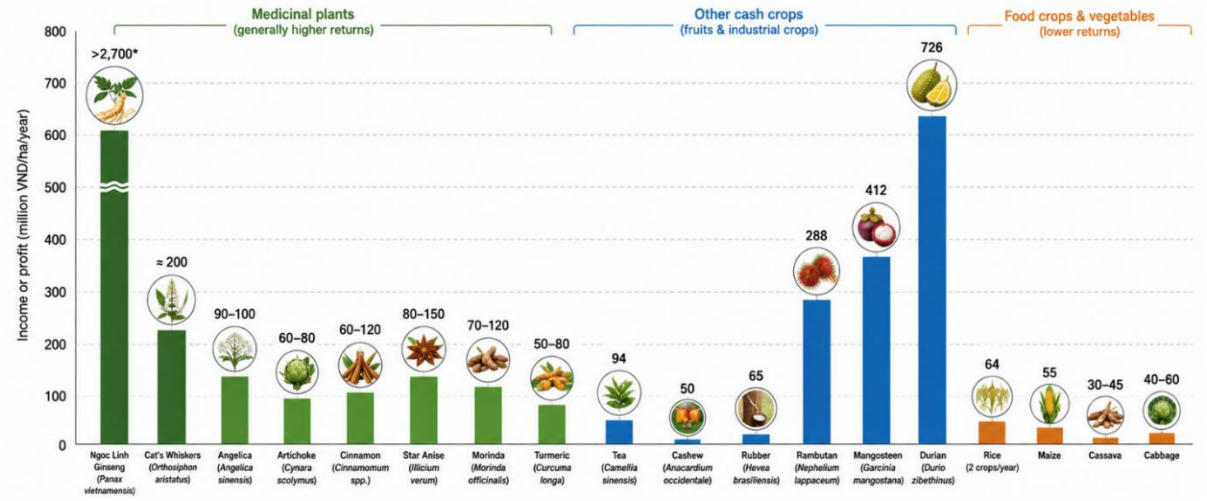


Figure 2. Economic Returns of Selected Medicinal Plants Compared with Conventional Crops in Vietnam.

Medicinal plant development also generates social benefits and contributes to strengthening rural livelihoods. The establishment of medicinal plant production areas creates demand for labor across multiple stages, including propagation, cultivation, crop management, harvesting, primary processing, transportation, and further processing, thereby contributing to employment generation and stimulating local economic activities. Mofokeng et al. (2022) emphasized that medicinal plant cultivation can provide opportunities for rural economic development and commercialization while contributing to healthcare systems and the sustainable supply of high-value plant resources [44]. These benefits are particularly relevant to mountainous areas and local communities in Vietnam, where knowledge of medicinal plant use has accumulated over generations. In Ben En National Park, Van Sam et al. (2008) documented 230 medicinal plant species belonging to 200 genera and 84 families, which were used by local communities to treat 68 categories of ailments [2]. Of these, 18 species were commercialized and contributed, on average, approximately 11% of household income. The study also found that 65% of the recorded medicinal species were collected from the wild and warned that traditional medicinal knowledge could be progressively lost among younger generations [2]. Sustainable medicinal plant development may therefore simultaneously support local livelihoods, diversify rural income sources, and contribute to the preservation and transmission of indigenous medicinal knowledge.

From a livelihood perspective, the development of medicinal plant cultivation areas can generate benefits beyond income from the direct sale of harvested materials. Local households may participate in different stages of the value chain, including seedling production, cultivation, harvesting, primary processing, transportation, and marketing, thereby diversifying employment and income opportunities. These benefits are particularly relevant to mountainous and rural communities where medicinal plant resources and associated traditional knowledge are concentrated. When cultivation is linked with stable markets, technical support, and local processing, medicinal plants can therefore contribute to livelihood diversification while creating economic incentives for communities to maintain and sustainably manage medicinal plant resources.

Another important benefit is the conservation of medicinal plant resources and reduction of harvesting pressure on wild populations. Growing demand for medicinal plants, combined with continued dependence on wild collection, can increase pressure on natural populations [44]. For example, in Ben En National Park, six medicinal plant species were listed in the Vietnam Red Data Book, while 18 species were considered locally threatened due to overexploitation [2]. Cultivation can consequently serve as an important complementary conservation strategy by providing alternative sources of medicinal raw materials while reducing dependence on wild harvesting [44]. To date, Vietnam has conserved 1,531 genetic resources representing 884 medicinal plant species, including many rare, threatened, endemic, and economically valuable species. Furthermore, the transition from uncontrolled wild harvesting to managed and standardized cultivation areas is important for ensuring the quality and stability of medicinal raw materials supplied to the pharmaceutical industry. Controlled cultivation can improve the consistency, quality, and purity of medicinal materials, which are essential requirements for pharmaceutical production and other products requiring standardized levels of bioactive compounds. Therefore, developing cultivation areas in accordance with standards such as WHO Good Agricultural and Collection Practices (GACP-WHO), together with traceability systems and linkages to primary processing, manufacturing, and markets, can facilitate the transformation of medicinal plants from primary agricultural and forest products into inputs for higher-value production chains. To support this transition, Vietnam has developed and issued more than 150 technical protocols for the cultivation, management, and processing of 40 medicinal plant species, providing technical guidance for organizations and individuals involved in medicinal plant production.

5. Advantages, Challenges, and Development Directions for Medicinal Plant Cultivation in Vietnam

5.1. Advantages.

Vietnam possesses favorable conditions for the development of medicinal plant cultivation areas toward specialized production and standardization. The rich diversity of indigenous medicinal plant resources, together with suitable growing environments, provides a strong basis for developing raw-material production areas associated with specific ecological conditions and geographical origins. Vietnam's tropical monsoon climate, combined with pronounced regional variations in topography, elevation, temperature, precipitation, and soil characteristics, creates diverse ecological subregions that support the cultivation of a wide range of medicinal plant species, from tropical and subtropical species to those adapted to cool and cold climates. In terms of climatic conditions, Vietnam extends across tropical and subtropical zones and exhibits pronounced climatic differentiation associated with latitude, elevation, and monsoon circulation. Warm and humid conditions with relatively high rainfall in lowland and mid-elevation areas are favorable for many tropical and subtropical medicinal plants, whereas cooler conditions in northern mountainous areas and high-elevation zones provide suitable habitats for medicinal species requiring lower temperatures [45, 46]. In addition, the diversity of soil types associated with mountainous, midland, alluvial, and basaltic landscapes provides a broad range of growing environments with different drainage, moisture-retention, and physicochemical characteristics. The combination of climatic gradients, altitudinal variation, and heterogeneous soil conditions therefore enables Vietnam to match the ecological

requirements of different medicinal plant species with specific production regions. This ecological differentiation represents an important advantage for establishing specialized cultivation areas for high-value medicinal plants, particularly when species selection is based on their ecological suitability and geographical origin. Medicinal plants contain diverse groups of bioactive compounds, including saponins, flavonoids, polysaccharides, anthraquinones, terpenoids, and phenolic compounds, which exhibit various biological activities such as antioxidant, anti-inflammatory, immunomodulatory, neuroprotective, and metabolic regulatory effects. These characteristics provide an important scientific basis for selecting and developing cultivation areas according to raw-material quality requirements and intended uses, while facilitating the integration of medicinal plant production with research, processing, and product development.

Government support policies have also provided substantial impetus for the transition from wild harvesting to organized medicinal plant cultivation. Among the relevant policies, Decision No. 1976/QD-TTg represents the key policy framework directly guiding the development of medicinal plant cultivation areas, particularly through the identification of priority medicinal species and ecological regions for cultivation. In addition, Decision No. 376/QD-TTg on the National Strategy for Development of Vietnam's Pharmaceutical Industry to 2030 and Vision to 2045 promotes the development of domestic medicinal raw materials, the application of GACP-WHO standards, and stronger linkages between cultivation, processing, and pharmaceutical production. For high-value medicinal species such as Vietnamese ginseng (Panax vietnamensis), policies have adopted an integrated development approach encompassing germplasm conservation, expansion of cultivation areas, processing, and brand development. Socio-economic development programs in mountainous regions have also created opportunities to integrate medicinal plant production with local livelihoods and enterprise participation. In parallel, Vietnam has established an initial technical foundation for the standardization of medicinal plant production. Investments in processing facilities have also been promoted to enhance the value and quality of medicinal plant products and to establish more stable market linkages and purchasing arrangements for medicinal plant growers.

5.2. Challenges.

Despite its rich medicinal plant resources and favorable ecological conditions, the development of medicinal plant cultivation areas in Vietnam faces several interrelated challenges, particularly those related to planting materials, fragmented production, limited standardization and traceability, weak value-chain linkages, insufficient advanced processing capacity, and inadequate investment. The capacity for research, selection, breeding, propagation, and quality control of planting materials remains limited, constraining the supply of genetically uniform and stable inputs required for large-scale production. Medicinal plant cultivation is generally small-scale and fragmented, with insufficient linkages among raw-material production areas, processing facilities, and markets, while the adoption of good agricultural and collection practices and traceability systems remains inconsistent. In addition, capacities for advanced processing, purification, and the development of science- and technology-intensive, high-value-added products remain limited. Many medicinal plant products have not received adequate investment in research on chemical composition, quality standards, safety, and efficacy, thereby limiting their competitiveness and access to international markets. Although policies supporting medicinal plant development, high-value medicinal plant cultivation areas,

and the pharmaceutical industry have been implemented, investment resources and the participation of enterprises in medicinal plant value chains remain insufficient relative to the country's potential.

5.3. Development Directions.

The above analysis indicates that the strategic focus of medicinal plant development in Vietnam should shift from expanding production scale toward improving the quality, consistency, and value of medicinal raw-material production areas. The advantages associated with genetic resource diversity and favorable ecological conditions can be transformed into competitive advantages only when integrated with planting materials of clearly documented origin, appropriate cultivation practices, rigorous quality and bioactive-compound control, and stable processing and marketing systems. Accordingly, medicinal plant cultivation areas should be considered an integral component of the medicinal plant value chain, with systematic linkages across genetic resources – planting materials – ecological zones – cultivation – quality/bioactive-compound control – primary processing and advanced processing – markets, rather than being developed as isolated agricultural production systems. On this basis, priority should be given to medicinal plant species and production areas that simultaneously meet three criteria: (i) distinctive advantages in genetic resources or specific ecological conditions; (ii) clearly identified demand for raw materials and market potential; and (iii) potential for standardization, advanced processing, and value addition. This approach provides a basis for transitioning from cultivation-area development driven primarily by acreage and production volume toward standardized medicinal raw-material production areas characterized by traceability, consistent quality, and high commercial value, thereby strengthening the competitiveness and long-term sustainability of Vietnam’s medicinal plant sector.

From a policy perspective, future development should prioritize long-term planning of specialized medicinal plant cultivation areas based on ecological suitability, genetic-resource advantages, and market demand. Policy support should focus on strengthening linkages among growers, cooperatives, enterprises, research institutions, and pharmaceutical manufacturers; improving access to high-quality planting materials; promoting the implementation of GACP-WHO and traceability systems; and encouraging investment in primary and advanced processing facilities associated with major production areas. Greater attention should also be given to mechanisms that integrate medicinal plant cultivation with the conservation and sustainable use of valuable genetic resources, particularly in mountainous regions where many high-value and endemic medicinal species are distributed. Stable purchasing arrangements and stronger enterprise participation are also important for reducing market uncertainty and supporting the long-term participation of local households in medicinal plant production.

Technological solutions should be developed in parallel with these policy measures and applied throughout the medicinal plant production chain. Priority should be given to the selection, propagation, and quality control of planting materials; the development and application of species- and region-specific cultivation protocols; improved monitoring of soil and environmental conditions, plant growth, pests, and diseases; and standardized harvesting and post-harvest practices. Technologies for drying, extraction, purification, quality assessment, and preservation of bioactive compounds should also be strengthened to improve the consistency, quality, and added value of medicinal raw materials. In addition, digital traceability systems can be applied to document the origin of planting materials, cultivation

areas, production practices, harvesting, processing, and product quality. The integration of these technological solutions with standardized cultivation and quality-control systems can support the transition from fragmented raw-material production toward more consistent, traceable, and higher-value medicinal plant value chains.

6. Conclusion

Vietnam possesses highly diverse medicinal plant resources and favorable ecological conditions, providing a strong foundation for the development of a sustainable and high-value medicinal plant sector. This review highlights not only the considerable diversity and pharmacological potential of medicinal plants in Vietnam but also the important role of cultivation in securing medicinal raw-material supplies, improving rural livelihoods, supporting the conservation of valuable plant resources, and reducing pressure on wild populations. Although medicinal plant cultivation has expanded across different ecological regions, its development remains constrained by fragmented production, limitations in planting-material quality and standardization, inconsistent application of good cultivation and traceability practices, weak linkages between growers, processors, and markets, and insufficient capacity for advanced processing and value addition. Future development should therefore move beyond the expansion of cultivation area and focus on improving the quality, consistency, traceability, and economic value of medicinal raw materials. Priority should be given to species and production areas with distinctive genetic and ecological advantages, demonstrated market demand, and strong potential for standardization and value-added processing. In particular, closer integration across genetic resources – planting materials – ecological zones – cultivation – quality and bioactive-compound control – processing – markets will be essential for transforming Vietnam's rich medicinal plant resources into competitive and sustainable medicinal raw-material value chains. Such an approach can simultaneously strengthen biodiversity conservation, secure domestic pharmaceutical raw-material supplies, enhance rural livelihoods, and improve the long-term competitiveness of Vietnam's medicinal plant sector.

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Author Contribution

Nguyen Van Thanh: Conceptualization, Methodology, Data Analysis, Writing; Nguyen Thi Thu Thuy: Methodology, Data Collection, Data Analysis, Writing. Le Duc Duy: Data Collection; Writing – review & editing.

Competing Interest

The authors declare no competing interests.

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