

STATUS AND DISTRIBUTION OF *TAXUS MAIREI* IN BAGAMATI PROVINCE



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Executive Summary

Taxus mairei, commonly known as South China Yew, is a critically endangered conifer with high ecological and commercial value due to its role in producing paclitaxel, a potent anti-cancer compound. In Nepal, particularly in Bagmati Province, *T. mairei* is confined to fragmented forest patches in mid-hill districts along the Mahabharat range. Despite its ecological and pharmacological importance, the species faces numerous threats including habitat fragmentation, overharvesting, poor regeneration, and lack of systematic cultivation. Recognizing these challenges, the current study assesses the natural distribution, threats, conservation initiatives, and commercialization potential of *T. mairei*, and proposes strategic interventions for its long-term sustainable use.

Culturally, *T. mairei* is deeply embedded in local traditions. Sacred groves and temples host century-old trees protected for religious reasons. The plant's leaves and wood are used in local rituals, instrument making, and traditional medicine. This cultural reverence, if harnessed properly, could support in situ conservation through community-based stewardship.

Bagmati Province harbors the highest number of medicinal plant species in Nepal and contains the country's only natural populations of *T. mairei*, making it a priority region for yew conservation. Field surveys, ecological mapping and stakeholder consultations were carried out across the species' natural range and nursery sites. Eleven natural pockets of *T. mairei* were identified, most located in community-managed forests in Sindhuli, Makawanpur, Kavrepalanchok, Dhading, Lalitpur and Kathmandu. These natural populations are fragmented, highly localized, and exhibit poor regeneration due to the species' slow growth and habitat degradation. Cultivation initiatives have been increasingly adopted by local farmers and community forest user groups (CFUGs), especially in Kavrepalanchok, Sindhuli, and Lalitpur. However, nursery activities are sporadic and largely dependent on market demand. While some private nurseries consistently supply seedlings and cuttings, others operate intermittently. A total of 16 nurseries are in operation in Sindhuli, Kavre, Lalitpur and Makawanpur districts with a annual production capacity of 50,000 seedling/sapling. Moreover, a total of 125 farmers of Sindhuli, Kavre, Lalitpur and Makawanpur are engaged in planting *T. mairei* in their farmland. Largest plantation is in Mangkal Rural municipality of Lalitpur district. These plantation have a potential to provide approximately 125 ton dry leaves annually. Despite the growing recognition of *T. mairei* as a viable non-timber forest product, commercialization remains constrained by a lack of quality planting materials, standardized harvesting protocols, and market coordination.

The commercial use of *T. mairei* gained momentum after the discovery that its leaves and twigs contain 10-deacetylbaccatin III (10-DAB), a precursor to paclitaxel. Initially, leaf biomass was exported in raw form, primarily by Dabur Nepal. More recently, companies like Evans Life Sciences established processing facilities to extract 10-DAB domestically. However, Nepal's contribution to the global taxol supply chain is still largely limited to raw and semi-processed materials, with final drug formulation occurring abroad. Trade is regulated under Nepal's CITES Act (2017) and its accompanying regulations (2019), with CITES permits and Non-Detriment Findings (NDFs) required for legal export.

To address critical challenges in *T. mairei* conservation and commercialization, a strategic framework has been proposed, focusing on six key issues:

Slow Growth and Poor Regeneration: Strategies emphasize ecological restoration, germplasm protection zones, and the development of propagation protocols to enhance seedling establishment and long-term population recovery.

Unsustainable Harvesting: Actions include awareness programs, harvesting manuals, and training for CFUGs on non-destructive, sustainable practices supported by community-based monitoring systems.

Lack of Ecological Research: GIS mapping, permanent ecological plots, and habitat fragmentation studies are recommended to support data-driven conservation planning.

Lack of Quality Planting Material: Elite genotypes with high 10-DAB content must be identified, and clonal banks and certified nurseries established to ensure consistent, high-quality propagation.

Lack of Optimized Harvesting Protocols: Scientific research is needed to determine optimal harvest seasons, biomass handling standards, and transport protocols to maximize 10-DAB yield.

Weak Commercialization Strategy: Recommendations include fair pricing models, support for domestic processing infrastructure, policy reforms to encourage investment, and strengthening community-industry-government linkages to promote equitable market participation.

This study underscores the need for multi-level coordination among federal, provincial, and local governments, with strong support from the private sector and local communities. Conservation and commercialization must go hand-in-hand, underpinned by sound science, clear regulation, and inclusive economic development strategies. With proper investment in ecological research, nursery development, market systems, and policy reform, Nepal has the opportunity to become a regional leader in the sustainable utilization of high-value medicinal plant resources such as *Taxus mairei*.

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1. Introduction

1.1 Background

Nepal, the Himalayan country harbor varied indigenous species of Medicinal plants from its low land Terai to High altitude alpine meadow. Over 2,500 medicinal plant species are used in traditional medicine in Nepal (Kunwar et al., 2020) and around 300 species are traded in domestic and international markets (Pyakurel et al., 2019). Among them species of Yews (*Taxus* spp.) are traded significantly high in amount both in terms of biomass and price (GoN, 2017), particularly when the anti-cancer properties of this taxa was discovered by the scientific community (Wani et al. 1971).

Commercial exploitation of the yews has increased several folds higher after the discovery of the anticancer compound paclitaxel however, yews and their products have a long history of utilization in the human civilization including along the Himalayas. The indigenous people of this area are using yews for more than 45 different purposes under 21 categories ranging from varied medicinal uses like gastrointestinal disorders, respiratory problems, skeletal system disorders, followed by fruit consumption, timber, fodder, fish poison and to make household tools, agriculture implements, and souvenir (Poudel et al., 2013).

Nepal shows unique biogeography regarding the distribution of Yew species. Using an integrative molecular-morphological taxonomic approach Poudel et al. (2012) had demonstrated an interesting distribution pattern of *Taxus* in Nepal. Occurrence of the two species of *Taxus* viz. *T. wallichiana* and *T. contorta* was relatively known however after Poudel et al. (2012), a third low altitude species *T. mairei* was also reported from Nepal.

Distribution wise *T. wallichiana* is distributed from the West Yunnan, China along the eastern Himalayas (South and Southeast Tibet, Bhutan and Northeast India) into Central Nepal (the eastern part of Baglung District). The second species *T. contorta* is confined to the western Himalayas, extending from East Afghanistan along the West Himalayas (North Pakistan and Northwest India) eastwards into Central Nepal and South West Xizang (Jilong valley).

The third and newly reported species for Nepal i.e. *Taxus mairei* was previously considered to be distributed in low to mid elevation forests in South China to Yunnan. However, Poudel et al. 2012 found its new distribution from south China a relatively narrow altitudinal range of 1400–2000 m in southern Vietnam, Southeast and Central Myanmar, Northeast India, Bhutan and Nepal. In Nepal it follows the distribution along the eastern and central part of the Mahabharat range (1000–2500 m) but concentrated only in Sindhuli, Kavre, Lalitpur, Kathmandu and Makawanpur (Bhatt et al. 2017).

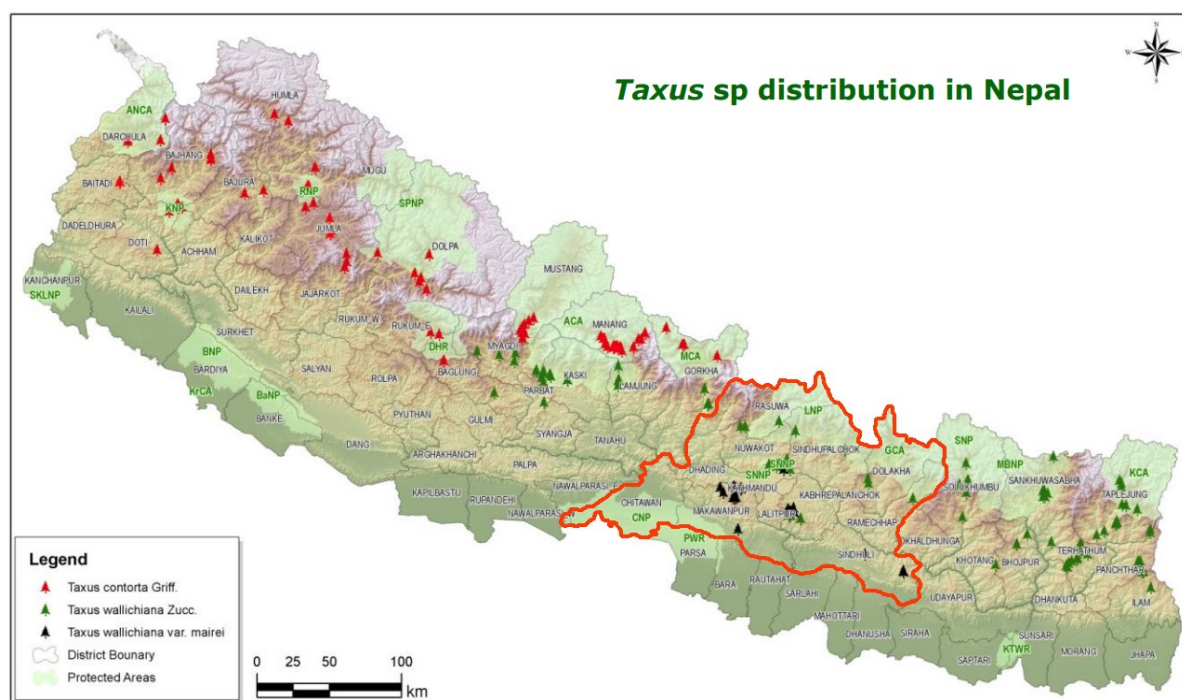


Figure 1. Highlighting the distribution of the *Taxus* species in Bagmati province (Source: DPR, 2021)

Since Bagmati province is a treasure trove of high value medicinal plants and hosts the highest number of used medicinal plants in Nepal (Kunwar et al. 2022), this province also shows high diversity regarding the distribution range of the *Taxus* spp. as well. *T. wallichiana* is distributed in most of its high altitude districts, whereas *T. mairei* occur in the lower belt of mid hills mostly along Mahabharat range in central Nepal.

Yews are enlisted in the IUCN red data book as endangered species. All the three species distributed in Nepal are also regulated by CITES to control excessive domestic uses and unscientific commercial harvesting in the early phase for the production of an anticancer drug (Mulliken & Crofton, 2008; Poudel et al., 2013). From some of the natural habitats, over 90% of the populations have been loosed. Low regeneration, habitat degradation at an unprecedented rate habitat fragmentation, high level of grazing and climate change in the recent decade are reported as key threats to the Yews of Bagmati province.

In this context robust and updated study of yews in the wild and cultivation is severely lacking. Similarly, the efforts from all the three tiers of government including the local people need to be documented properly for making decision on sustainable conservation, farming and regulating the trade of these species both in wild and cultivation.

1.2 Objectives

The general objective of this assignment is to assess the natural distribution and conservation threats of *Taxus mairei* in Bagmati province and analyze the government/community/individual level initiatives for its promotion, sustainable use, trade and conservation in the province.

The specific objectives are:

- Map the current status, distribution and population of *Taxus mairei* in the Bagmati Province and document the natural pocket areas.
- Document the conservation practices adopted by different stakeholders including all three levels of government.
- Document *T. mairei* nurseries developed for conservation and commercial purposes and map the seedling/sapling planted and annually available for plantation in the future.
- Catalogue the subsistence use, cultural use and trade use of *T. mairei* and map the trade/collection centers and trade route of in the province.
- Map the available processing facility and its centers in the province.
- Identify the threats, challenges and problems associated with *T. mairei* cultivation, and marketing and recommend some strategic action plans for its viable commercial cultivation.

1.3 Limitation

Major constrain of this study was limited time and financial inadequacy to visit all the plantation sites and report exact biomass of each plantation sites through standard ecological sampling.

2. Methodology

2.1 Study area

Bagmati Province is located in central Nepal (Figure 2) occupying Tarai, midhills and high Himalayan regions covering 13 districts. It lies between 83°55' and 86°34' east longitude and 26°55' and 28°23' north latitude. It has an area of 20300 sq km, about 13.79% of the total area of the country. Out of which 27.29% land is covered by forest and 24.34% land is used for agriculture purpose. It is bordered by Tibet-China in the north, Gandaki Province in the west, Madhesh Province and state of Bihar in the south and Koshi province is to its east. Chitwan is the only Tarai district of this province.

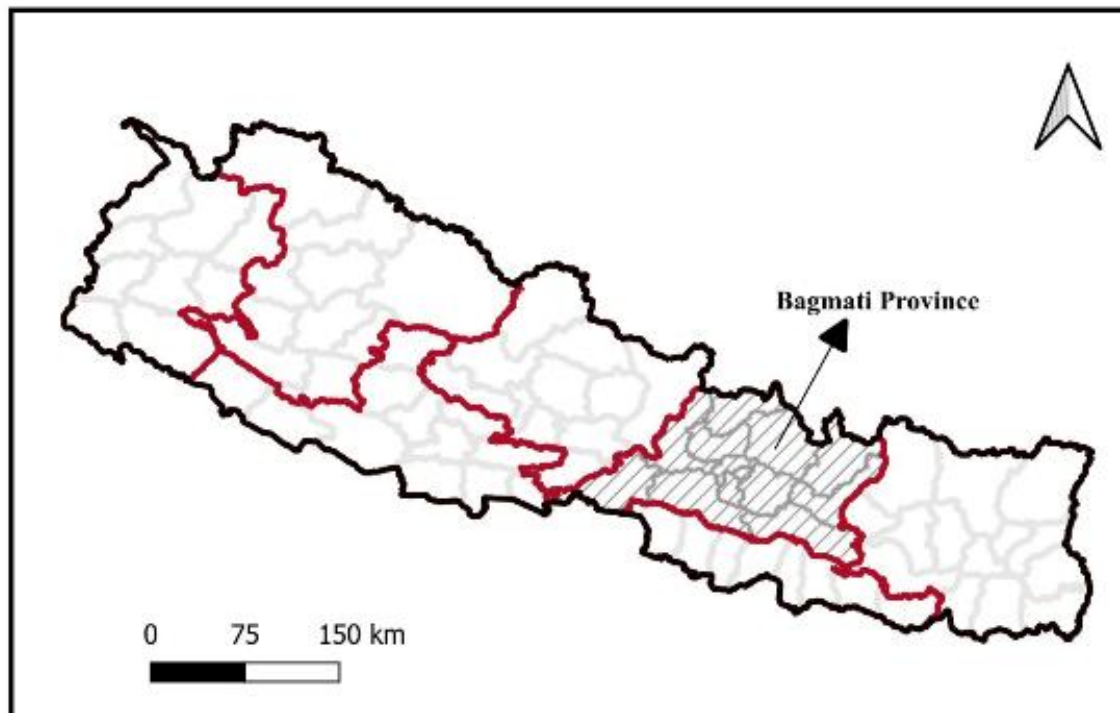


Figure 2. Map of Bagmati Province

Bhitrai Madhesh and Mid hills districts are Bhaktapur, Kathmandu, Kavrepalanchok, Lalitpur, and Makawanpur. While, Dhading, Dolakha, Nuwakot, Ramechhap, Rasuwa, Sindhuli and Sindhupalchok are the High hill districts in the Bagmati province. There are 119 local governments composed of three metropolitan cities, 1 sub metropolitan cities, 41 municipalities, 71 rural-municipalities and 1121 wards. Hetauda is the provincial capital and serves as a key economic and administrative center. The province is rich in diverse ecosystems and different vegetation types, with distinct tropical, temperate, and alpine vegetation zones. Major forest types include Sal (*Shorea robusta*) forests in Tarai, lowlands, oak-rhododendron forests in the mid-hills, and coniferous forests in the high altitudes. *T. wallichiana* grows well in the broad leaved mixed forest associated with Abies, Acer, Pinus, Quercus, Rhododendron, Tsuga, bamboos and laurels. Observed mostly along Northeast and South facing slopes, common inside forests, along humid riversides and valleys. Grows in well-drained soil.

T. mairei is low altitude yew. Its habitat range between 1500–2000 m along the Himalayas and adjacent regions. In Central and East Nepal this species occurs in broadleaved forests along the Mahabharat range. Given the high density of human settlement and agriculture

land in mid hills, the natural population of *T. mairei* is highly fragmented and scattered. The conservation status of *T. mairei* growing in natural condition is of serious concern (Poudel et al. 2012) and the latest National Red List Assessment of this species has assessed as CRITICALLY ENDANGERED B2ab (iii, iv, v) (Hughes et al. 2023). This study has focused on the districts of Bagmati Province where *T. mairei* is naturally distributed and also cultivated by the farmers.

2.2 Data collection techniques and tools

This study has adopted a mixed-methods approach, integrating both qualitative and quantitative research techniques to ensure a comprehensive analysis. Quantitative methods will be utilized to obtain measurable data, while qualitative methods will provide in-depth insights into *T. mairei* related information. Data was sourced from both primary and secondary sources, with a primary reliance on secondary data, supplemented by field studies for additional context. To achieve a well-rounded understanding, various data collection techniques and tools will be employed, including: (i) a comprehensive desk review, (ii) web-based research, (iii) trade analysis, (iv) consultative meetings and (v) key informant interviews (KII).

2.2.1 Comprehensive desk review and web browsing

A comprehensive review of secondary data and information is a crucial aspect of this study, enabling the research team to consolidate existing knowledge on various aspects of *T. mairei*. The review encompass:

- Relevant policies, laws, and directives concerning the in situ and ex situ conservation of *T. mairei* including the aspects of its trade.
- Other relevant literature, which include review of journal articles, books, government reports and popular articles to provide a broader contextual understanding.

2.2.2 Field observation and sampling

Field visits was conducted to understand the natural distribution of yew species and their population status and document the existing threats. GIS map was prepared for each district showing the wild population and nurseries. Snowball sampling was employed to identify and locate community forests and farmers involved in *T. mairei* conservation, nursery management and cultivation within the province. A free-listing of all individuals growing *T. mairei* was compiled. Major cultivation sites were visited. Natural strands of *T. mairei* was also visited This present study has updated the earlier records of the natural strands of *T. mairei* and also verified and recorded additional information of the earlier distribution, based on the field visits, consultations with relevant stakeholders.

Field visit is followed by interviews to gather data on the following.

- (i) Natural Strand and the status of regeneration,
 - (ii) natural and anthropogenic threats,
 - (iii) Cultivation area,
 - (iv) Number of cultivated plants,
 - (v) Means of propagation/cultivation,
 - (vi) Year of planting,
 - (vii) Other peer cultivators and interested farmers and their address/locations,
 - (viii) Trade and its prospects,
 - (ix) Processing/value addition practices
10. the support provided by government and non-government agencies.

2.2.3 Focus group discussion and consultative meetings

The Focus Group Discussion (FGD) was aimed to explore the natural strand and potential of *T. mairei* cultivation in Bagmati Province, focusing on key areas such as pocket areas for *T. mairei* cultivation, feasibility of expanding its cultivation and also identify challenges in cultivation. Furthermore, the FGD evaluated key stakeholders and areas for growth, production, processing, and marketing facilities, along with the necessary requisites for successful development. In addition to FGD, focused meetings was essential for collecting data and gaining a comprehensive understanding of *T. mairei* farming, its trade, value addition potentials in the province, individual farmer currently practicing cultivation of yew, thereby supporting the development of effective strategies and interventions.

2.2.4 Key Informant Interviews

Key Informant Interviews (KIIs) was conducted with key individuals who were directly involved in various aspects of *T. mairei* conservation, cultivation, nursery management, trade, ethnobotany, marketing and policy planning. Key informants were representatives from the Ministry of Forest and Environment (MoFE), Division Forest Offices (DFOs), the Forest Research and Training Center (FRTC), Community Forest User Groups (CFUGs), Farmers, Traders, Researchers, and other relevant stakeholders. These consultations played a vital role in gathering expert opinions, identifying gaps in the existing framework, and formulating strategies to conserve *T. mairei* in its natural state and expand the cultivated areas.

2.3 Ecological study

2.3.1 Ecological sampling

Ecological sampling was performed for limited natural strands of Kavre, Sindhuli and Makawanpur following purposive sampling. Majority of naturally grown trees were measured for their DBH and height.

2.3.2. Participatory and GIS mapping

Cultivation sites and the number of the natural strand of *T.mairei* were identified and mapped using GIS maps. These maps were helpful to illustrate the distribution and density of *T. mairei* forest and cultivation sites. Additionally, key site related to the production, processing, and marketing of *T. mairei* was mapped. These maps will serve as valuable tools for understanding the spatial distribution of *T.mairei* forest, cultivation sites, processing facilities, and marketing centers, enabling stakeholders to identify gaps, areas for improvement, and potential opportunities for expansion in the *T. mairei* value chain.

2.4 Data analysis

The data analysis for the *T. mairei* survey was combined using both qualitative and quantitative methods. Qualitative data from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) was analyzed using thematic analysis to identify key themes, challenges, and opportunities related to *T. mairei* production, marketing, and conservation. For quantitative analysis, mapping data was used to visualize the distribution of cultivation sites, production, and processing locations. Biomass estimates was calculated using DBH following allometric equations. QGIS was used for spatial mapping and analysis, allowing for the visualization of *T. mairei* forest, cultivation, production, and processing sites, helping identify potential areas for expansion.

3. Plant Profile

3.1 Taxonomic Detail

Botanical Name: *Taxus mairei* (Lemée & H. Léveillé) S.Y. Hu ex T.S. Liu

Synonyms: *Tsuga mairei* Lemée & H. Léveillé; *Taxus chinensis* (Pilger) Rehder var. *mairei* (Lemée & H. Léveillé) W.C. Cheng & L.K. Fu; *Taxus wallichiana* var. *mairei* (Lemée & H. Léveillé) L.K. Fu & Nan Li

English Names: South China Yew, Mairei Yew

Local Names: Machhindra pati, Lauth salla, Pate Salla, Barne Salla

Taxonomic description: Evergreen understorey tree of 5-25 meters. Bark peeling off in stripes. Bud scales few and persistent at base of the branchlets. Leaves arranged on two lateral rows on branchlets, broadly lanceolate, thin, falcate, base asymmetric, apex obtuse, without papilla or rarely papillate below, midrib and leaf margin underneath shiny. Loosely to compactly arranged 11-16 stomatal bands, margin revolute when dried. Male and female flowers grow in different individual trees. The male cones are globose and scattered along branchlets. Seed arises from the base of leaves, ovoid, enclosed by a fleshy aril, which turns red when ripen; seed bilaterally flattened. Flesh aril is edible. Wind pollinated.

3.2 How can *T. mairei* be distinguished from other *Taxus* species in Nepal?

Taxus mairei can be easily identified in the field with the help of few morphological characters. First of all, this species is naturally found at elevation below 2000 meters. Its natural populations in Nepal are concentrated in the limited areas of Mahabharat range of Sindhuli, Kavre, Makawanpur, Kathmandu and Dhading districts. Morphologically *T. mairei* differ with other species in the shape of the leaves, the leaf margin underneath and bud scales as presented in Table 1.

Table 1. Ecological and morphological differences among the three yews of Nepal

Features	<i>Taxus mairei</i>	<i>T. wallichiana</i>	<i>T. contorta</i>
Geographic distribution	Mostly below 2000m	Above 2200-3500	Above 2100-3600
Area of natural occupancy	Central Nepal	East – Central Nepal	Central-West Nepal
Leaf shape	Broadly lanceolate	Narrowly lanceolate	Linear-straight
Shiny mid rib/ leaf margin	Present	Absent	Absent
Bud scales	Few-none	Dense	Few-none



Shiny midrib and leaf margins



Typical sigmoid leaves with shiny margins



Leaves with few non distinct laves and bud scales



Female fruit (cone) of *T. mairei* with red aril



Male fruit (cone) of *T. mairei*

Flowering season: March – May; **Fruiting season:** September-November

Figure 3. Morphological features of *T. mairei*

3.3 Geographic Distribution of *T. mairei*

Global distribution: *T. mairei* is dominant species of South east China. Its distribution extends to the lower elevation areas of neighboring countries like Vietnam and Myanmar. From Myanmar *T. mairei* migrated westward to North East India (Meghalaya) and Nepal. Herbarium records of this species from Thailand and Bhutan reveal its historical occurrence (Poudel et al. 2012) however currently there are no populations which implies *T. mairei*'s extinction from both of these countries.

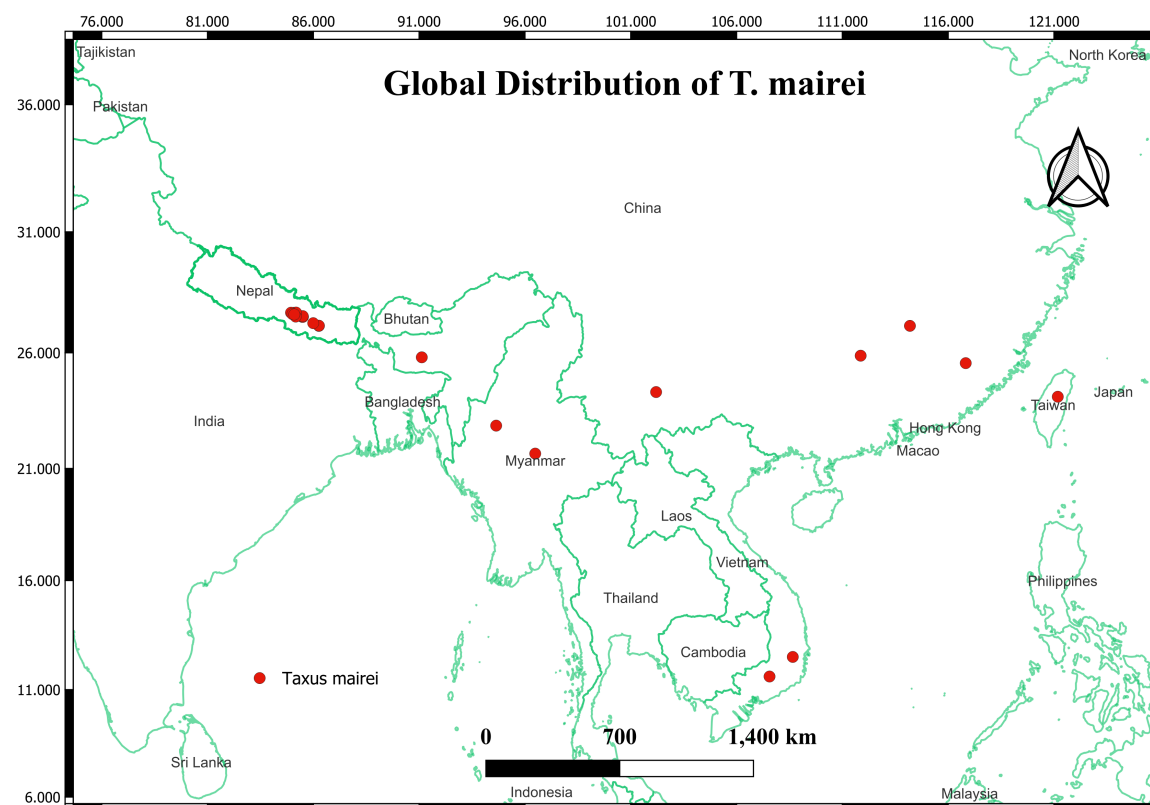


Figure 3.Global distribution of *T.mairei*

3.4 The Earliest Collection of *T. mairei* Specimen was from Nepal !

Taxus mairei was originally collected by E.E. mairei, however incorrectly named as *Tsuga mairei* in 1914 (Léveillé 1914). Rehder (1936) correctly identified this species as *Taxus* but he also misidentified as *Taxus chinensis*. *T. mairei* was published in Illustrated Native and Introduced Ligneous Plants of Taiwan, Volume 1, page 16 by Liu (1960), however Cheng and Fu (1978) treated this under the variety of *T. chinensis* which was also the illegitimate combination. This species was transferred to *T. wallichiana* and treated as variety by Fu & Li (Li and Fu 1997). The recent morphological and molecular work have supported the treatment of Liu (1960) as a distinct species.

Interestingly Flora of Nepal, Chief Editor Dr. Mark F. Watson has discovered that *T. mairei* was collected from Kathmandu valley by Buchanan-Hamilton from Chitlang area in 16 October 1802 and 21 Jan 1803. In field notes of Buchanan-Hamilton, description of the species and local Newari name 'Losswa' had been documented. Although Buchanan-Hamilton did not publish the name officially, he named this species 'Taxus lossua Buch. as new species in his field note.

David Don published *Prodromus Florae Nepalensis* in 1825. This book was primarily based on plant specimens collected by Buchanan-Hamilton during his expedition through Nepal in 1802–1803. Don utilized these specimens to describe numerous species, including ferns and flowering plants, marking the first comprehensive botanical treatment of Nepal's flora.

Don had access to Buchanan-Hamilton's specimens through Aylmer Bourke Lambert, a prominent botanist and collector. Don worked as Lambert's librarian, which allowed him to study the Nepalese specimens extensively. These specimens were later acquired by the British Museum in 1842, ensuring their preservation and continued study.

It is surprising that although the specimens of *T. mairei* were earlier in the Lambert herbarium, David Don did not include them in his *Prodromus* in 1825 that is the reason why our Nepalese collection of *T. mairei* collected almost 100 years before the collection of *E.E. mairei* from south china in 1914 could not become the worlds' earliest collection of *T. mairei* and got its official naming.

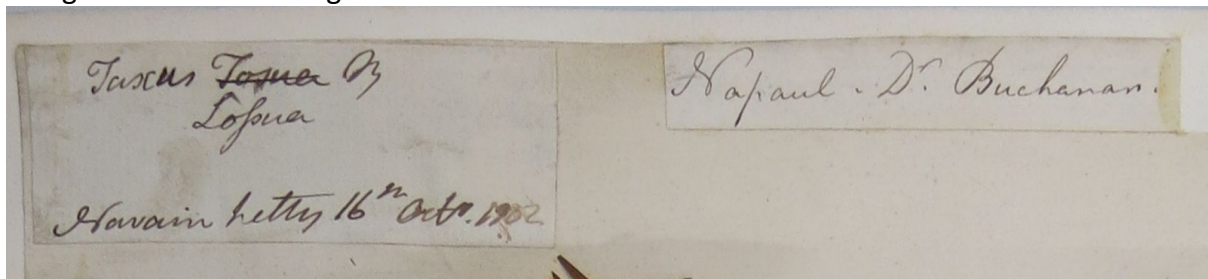


Figure 4. The earliest naming of *Taxus mairei* as 'Taxus losoua' by Buchanan Hamilton (Buchanan-Hamilton, F. (BM) IMG_9823)



Figure 5. World' earliest collection (not officially reported) of *T. mairii* from Nepal collected by Buchanan-Hamilton during his stay in Nepal 1802-1803. This specimen is currently deposited in British Museum. Image credit: Dr. Mark F. Watson, Editor Chief of the Flora of Nepal Project

3.5 Updated Distribution of *T. mairei* in Nepal

Extensive population based morphological and molecular study carried out by Poudel et al. (2012) using yew specimens collected from Hindu-Kush Himalaya and adjacent regions, strongly established the non overlap occurrence of the three distinct species of yew viz. *T. wallichiana*, *T. contorta* and *T. mairei* including in Nepal. His study was expanded further by Bhatta et al. 2017 reporting more wild populations of *T. mairei* particularly from the Makawanpur and Kathmandu district (Figure 7). Natural occurrence of *Taxus* in Nepal is limited to Bagmati province. This study has extended the natural population of *T. mairei* in the Mahadev Kharka area of the Dhading district. The updated natural distribution of *T. mairei* in Nepal covers six districts i.e. Makawanpur, Dhading, Kathmandu, Kavre, Sindhuli and Lalitpur as shown in the figure 7.

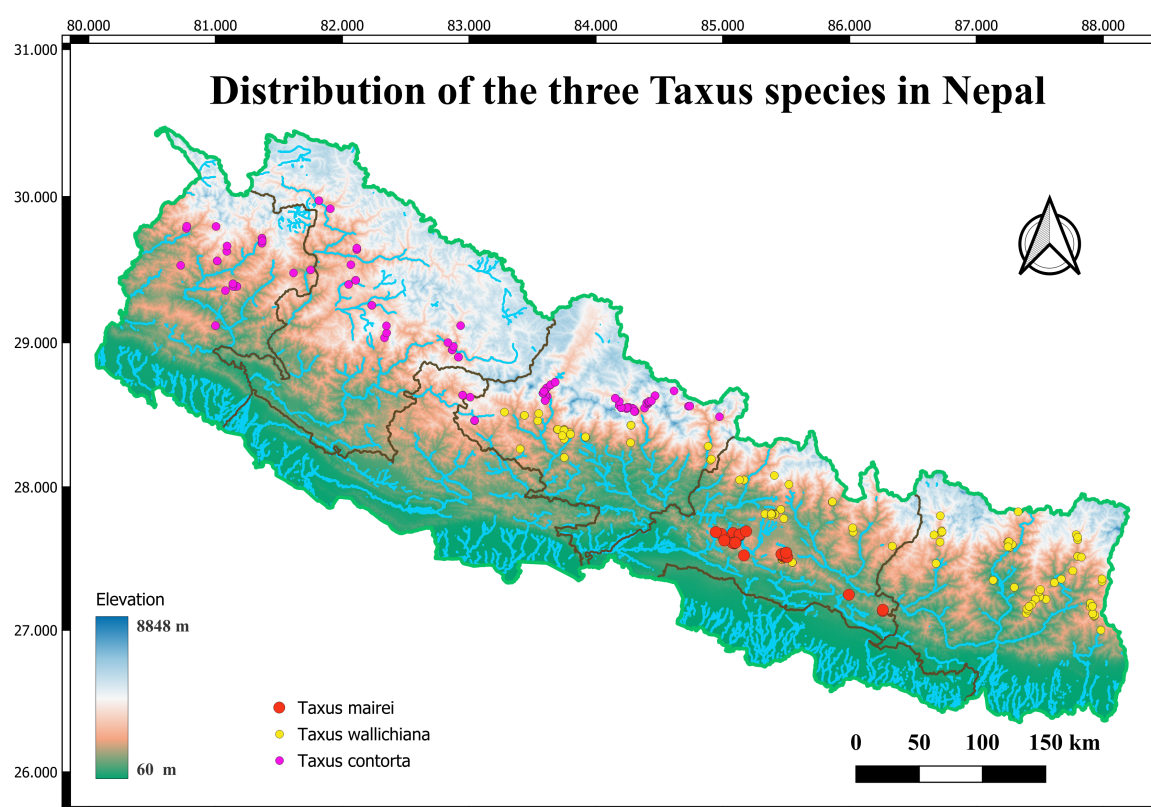


Figure 6. Distribution of *Taxus mairei* in Nepal (updated data of Bhatta et al. 2017)

3.6 *Taxus mairei* is Limited to Bagmati Province

The natural distribution of *Taxus mairei* in Nepal is primarily within the fragmented areas of the inner Himalaya or the Mahabharat lekh (range) across a few districts of Bagmati province. This species is typically found in the lower elevation ranging from 1700 to 2200 meters. In China its vertical distribution extends much lower 100 meters to the highest 2100 meters above sea level.

Interestingly natural population of *T. mairei* having old trees aged 100 years up to above 300 years can be observed inside the forest and few along the margin of the agriculture land. If we compare the distribution areas and the range of all the three species of *Taxus* in Nepal, the natural distribution of *T. mairei* can be found along certain section of mahabharat range located inside the area of Sindhuli and westward to Makawanpur and Kathmandu. The

eastern Himalayan Yew, *Taxus wallichiana* is also found in Bagmati province however this species prefers higher elevation ranging from 2200-3500 (3600). *T. mairei* and *T. wallichiana* do not grow together or overlap in their distribution. These two species occur naturally in Kathmandu and Kavre districts however habitat are distinctly different. In Kathmandu district *T. wallichiana* grows naturally in Shivapuri national park at an altitude range of 2300-2500 m while *T. mairei* is growing in just the opposite direction at 1900 m of Masina Community Forest located inside Chandragiri Municipality 2. Similarly, in case of Kavre district *T. wallichiana* is growing at an altitudinal range of 2400-2600 m, but *T. mairei* is growing in lower elevations below 2100, sometimes even in the foothills of the same mountain which has *T. wallichiana* in higher elevations (Figure 8).

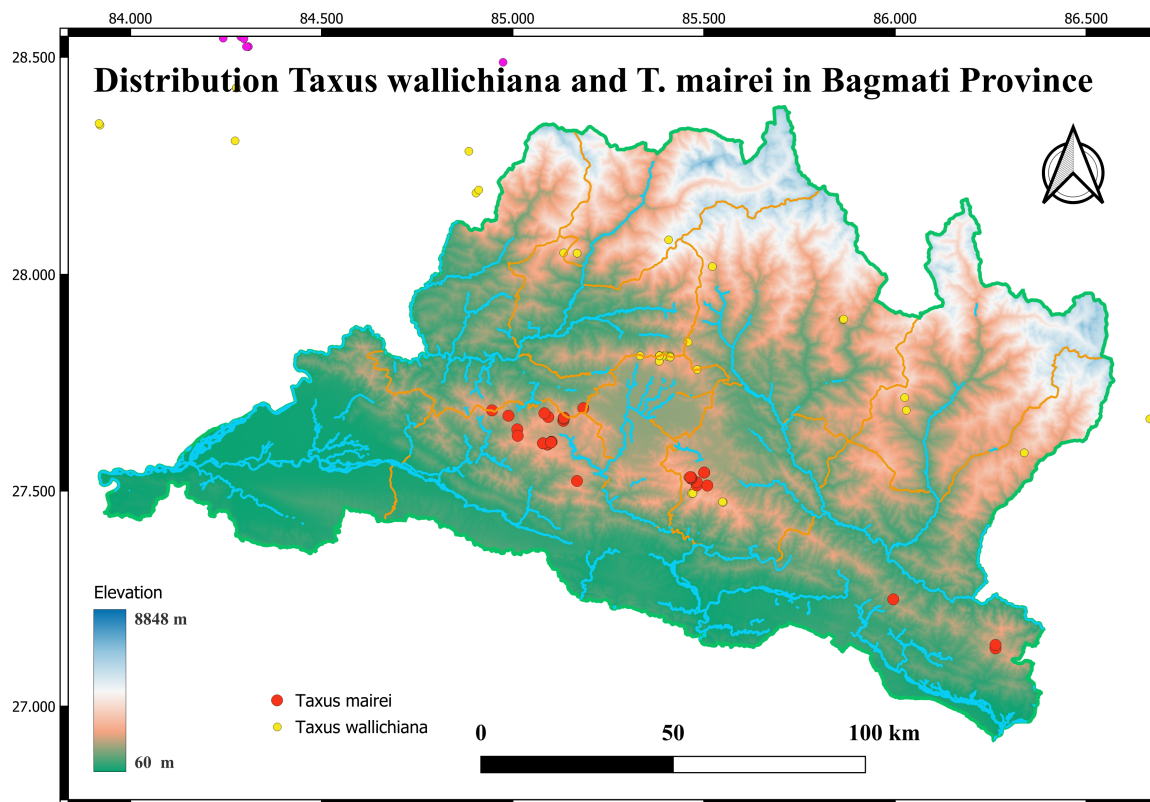


Figure 7. Distribution of *T. mairei* and *T. wallichiana* in Bagmati province

Taxus mairei is found in the evergreen broad leaved forest as an understorey species. Subtropical to lower temperate vegetation is characterized by Schima-Castanopsis forest and few deciduous species and conifer in some areas. The major associates species are *Eurya acuminata*, *Quercus glauca*, *Myrica esculenta*, *Myrsine capitella*, *Berberis aristata*, *Antidesma acuminatum*, *Crotalaria cytisoides*, *Osyris wightiana* etc. In some areas *Rhododendron aroboreum*, *Sarcococa coriacea*, *Lyonia ovalifolia*, *Rubus ellipticus*, *Melastoma malabaricum*, and *Maesa chisia* are also found sharing the habitat of *T. mairei*. *T. mairei* is normally found growing along the gorges and nearby the water courses with adequate humidity.

3.7 Natural Populations and Pocket Areas of *T. mairei*

T. mairei is Sino-Japanese species. This species is native to east Asia particularly South China, Taiwan, Vietnam, Myanmar and north-east India. Nepalese populations are the westernmost distribution of *T. mairei*. These are the edge of species distribution representing the furthest point west. Natural populations of *T. mairei* in Nepal are observed in the subtropical broadleaved forests of the five districts of Bagmati province viz. Sindhuli, Kavre, Makawanpur, Kathmandu and Dhading. All these natural populations are highly fragmented and isolated. Given the high anthropogenic activities along the Mahabharat range, isolated populations in the natural range are surviving as refugia. Koshi river in the east and Sunkoshi river in the north function as a natural barrier for this species leading to the current distribution range. All natural populations are located inside the community forests (Figure 10,11 and Table 10 and 11) except the population of Mahadev danda-Damar, Sindhuli which is along the edge of farm land. Majority of these populations are survived in isolated pockets in the community forest and some are grown along the edge of agriculture land. After the discovery of 'Taxol' an anticancer compound, yews got global attention so as the increased pressure on the natural population. Many natural populations got extinct due to the traditional and commercial use while few new population were also established through plantations as shown in Figure (10)

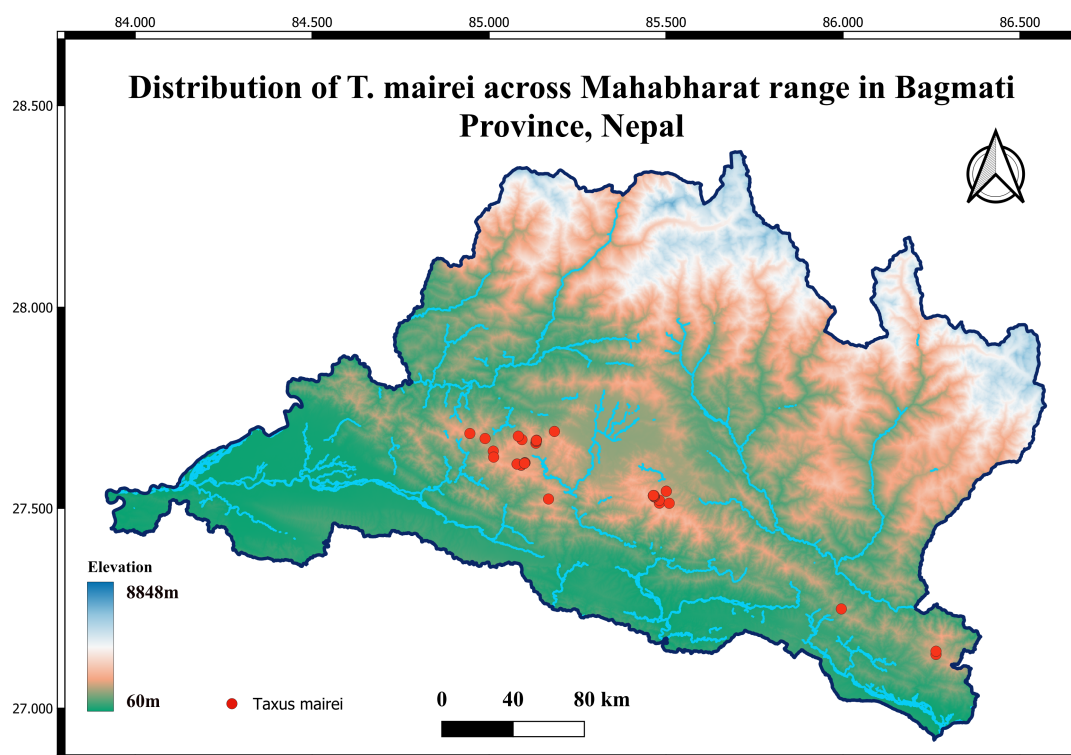


Figure 9. Occurrence of *T. mairei* populations along Mahabharat range in Bagmati province

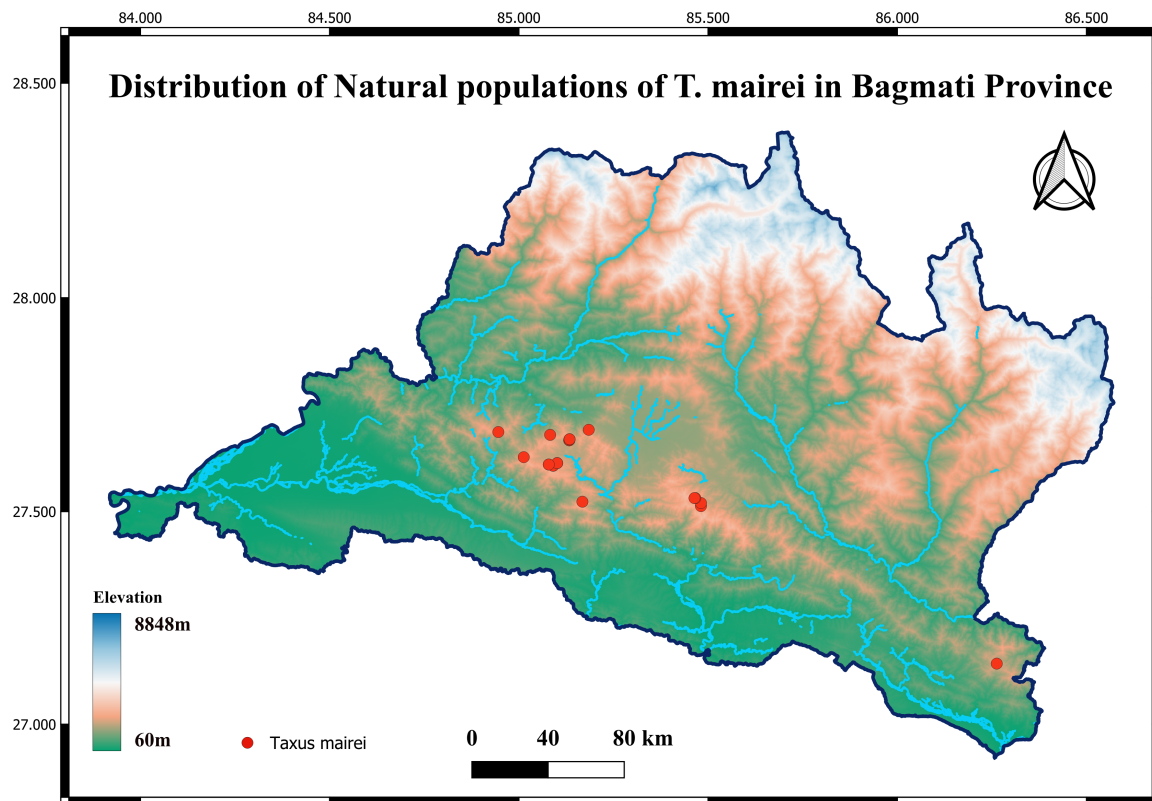


Figure 10. Distribution of *T. mairei* natural populations in Bagmati province

Table 2 . Locality information of the natural strands of *T. mairei* found along its distribution range in Bagmati province.

SN	District	Locality	Forest area	Tree/leaf biomass
1	Sindhuli	Mahadev Kharka; Majhkharka	Along the edge of farmland	Around 40 trees
2	Makawanpur	Loshepakha	Chulipran Community Forest	Around 35 trees
3	Makawanpur	Kailash Gau Palika, 5	Kalikhola Community Forest	Around 200
4	Makawanpur	Rupse	Mahakal Community Forest	5 trees
5	Makawanpur	Jakarghari	Karunabhumi Community Forest	5 trees
6	Makawanpur	Palung	Risheswar Community Forest	Around 30 trees
7	Makawanpur	Cogate	Himchuli Community Forest	6 trees
8	Dhading	Mahadevkharka		Around 50 trees
9	Kavre	Dhungkharka	Patnebhanjyang community forest	Around 20 trees
10	Kavre	Bharkhethanti	Along the edge of farm land	20 trees
11	Kathmandu	Chandragiri Municipality	Masine Community Forest	15 trees
12	Lalitpur	Gotikel	Sisban	10 trees

3.8 Area of Occupancy and Extent of Occurrence of *T. mairei*

The Area of occupancy and the extent of occurrences are metrics used to calculate the area where the species is actively inhabiting and the total geographic area where a species is distributed. These metrics provide valuable insights into the specific habitats and conservation status of the species. Based on the occurrence data of *T. mairei* the Extent of occurrence (EOO) and Area of occupancy (AOO) was estimated to be 4851 km² and 64 km² respectively. According to the IUCN thresholds for Criterion B the calculated value EOO and AOO implies the 'Endangered' status of *T. mairei*. EOO and AOO are only the few criteria, we have to consider other criteria like counting the number of locations or check for fragmentation; check for ongoing in habitat, population, etc., and document fluctuations, if any in this study meets. Hughes et al. 2023 has determined the local conservation status of *T. mairei* considering all the criteria's needed for conservation assessments. So far the conservation assessment suggested by Hughes and her team was CRITICALLY ENDANGERED B2ab (iii, iv, v).

3.9 *T. mairei* in Sacred Groves/Religious Forest

The *mairei* yew itself and its old trees are regarded as sacred species thus grown in sacred grove or religious forest including public resting place locally called 'Chautari' built along the walking trail. Old trees were found protected in Kavre (Chalal Ganesh), Makawanpur (Agara, Chulipran area and Dadabas) and Sindhuli (Mahadev Danda). Tree protected in Chalal Ganeshthan has more than 13 trunks with dbh 20 cm. Interestingly such practice widely common in Europe where *Taxus baccata* is protected around the Church premises is also found in Nepal. Leaves of *Taxus mairei* are offered to Bajrabarahi Devi, goddess worshiped in an auspicious event organized in every three years at Bajrabarahi Temple, Tistung. Locally *Taxus mairei* leaves are called as Machhindra pati. Similarly Tamang of Dandabas, Agar also uses it leaves for their religious purposes.



Figure 11. Tree of *Taxus mairei* planted in the resting place, Agara village, Makawanpur.



Figure 12. Old tree of *Taxus mairei* protected in the Sacred grove in Mahadev danda, Sindhuli (Photo credit: Mahendra B. Shahi, Sindhuli)



Figure 13. Highly branched trunk of an old tree of *Taxus mairei* protected in the Sacred grove in Mahadev danda,Sindhuli (Photo credit: Mahendra B. Shahi, Sindhuli)



Figure 14. *T. mairei* protected for its religious value in Dandabas, Makawanpur



Figure 15. Old tree of *Taxus mairei* with more than 15 trunks protected nearby the temple of Chalal Ganesh, Kavrepalanchok (front view).

4. Nursery Status and Cultivation Practices

4.1 *T. mairei* nurseries in Bagmati Province

The growing commercial demand for Taxol can only be met through large-scale cultivation of *T. mairei*. Due to the limited availability of natural stands, harvesting from already fragmented populations would push the remaining wild stock toward the brink of extinction. Fortunately, in Nepal, all key stakeholders including conservationists, policymakers, traders, community forest user groups, and farmers recognize the necessity of commercial cultivation. This approach offers multiple benefits: it supports the conservation of remaining natural stands, meets the increasing demand for *Taxus* leaves required in Taxol production, and generates income at the local level through sustainable farming practices.

To support both commercial and conservation objectives, *T. mairei* nurseries have been established in key pocket areas, with partial or full support from Division Forest Offices and Botanical Gardens under the Department of Plant Resources. In many instances, these nurseries have also been developed through the sole investment of private farmers committed to medicinal plant cultivation. In Bagmati Province, leading farmers and active community forest user groups including cooperatives of medicinal plant growers are maintaining *T. mairei* nurseries. These nurseries serve as the primary source of saplings and seedlings for farmers and community forests interested in cultivating *T. mairei* across the province. (Table 3).

Table 3. *T. mairei* nurseries developed for commercial and conservation purposes.

SN	Nursery	Purpose	Seedling/cuttings	Annual available	Remarks
1	Makawanpur Himchuli CF, Cogate	Conservation	Cuttings	500	Poorly managed
2	Makawanpur Mountain Botanic Garden, Daman	Conservation	Cuttings	300-500	Based on annual program, distributed to community forests
3	Kavrepalanchok Krishi Ban Jadibuti Nursery Ram Prasad Timilsina	Conservation/ Commercial	Seedling/ Cuttings	3000	Supplied to division forest office and interested farmers
4	Kavrepalanchok Khahare Jadibuti Nursery Krishna Prasad Timilsina	Conservation/ Commercial	Cuttings	1000- 2000	„
5	Kavrepalanchok Gopal Prasad Timilsina	Commercial	Cuttings	1000- 1500	„
6	Kavrepalanchok Min Raj Timilsina	Commercial	Cuttings	1000	„
7	Kavrepalanchok Gopal Prasad Timilsina	Commercial	Cuttings	1000	„
8	Kavrepalanchok Ram Bahadur Timilsina	Commercial	Cuttings	1000	„
9	Kavrepalanchok Ram Prasad Nepal	Commercial	Cuttings	1000	„
10	Kavrepalanchok Prem Bahadur Timilsina	Commercial	Cuttings	1000	„

SN	Nursery	Purpose	Seedling/cuttings	Annual available	Remarks
11	Lalitpur, Mahankal Rural Municipality [more than 5 active nurseries]	Conservation/ Commercial	Seedling/ Cuttings	5000-20,000	Generally sold to interested farmers
12	Sindhuli, Majhkharka Fikkal Jadibuti Sahakari	Conservation/ Commercial	Seedling/ Cuttings	5000-1000	Supplied to division forest office and interested farmers
13	Jainda Bahadur Budhthoki	Conservation/ Commercial	Seedling/ Cuttings	3000-5000	Supplied to division forest office and interested farmers
14	Bel Bahadur Budhathoki	Conservation/ Commercial	Seedling/ Cuttings	3000-5000	Supplied to division forest office and interested farmers
15	Ganesh Budhathoki	Conservation/ Commercial	Seedling/ Cuttings	3000-5000	Supplied to division forest office and interested farmers
16	Lalitpur, Godawari National Botanical Garden	Conservation/ Commercial	Cuttings	Up to 5000	Selling seedling in polybags for visitors

Among the above mentioned nurseries a cooperative of Sindhuli and privately owned nurseries of Kavre (Dhungkharka area) and Lalitpur (Mahankal and Badikhel) are regularly producing seedling and cuttings propagated from twigs. They have supplied seedling to several division forest offices and interested farmers of Sindhupalchok, Dolakha, Ramechhap and even to the districts of another province like Gorkha, Dhading, Okhaldhunga, Khotang, Ilam etc. *T. mairei* nurseries are active in Kavrepalanchok, Sindhuli and Lalitpur districts, having minimum 5 active nurseries in each districts. Most of them regularly prepare cutting and seedling while remaining prepare seedling depending on the market demand. Kavre district is followed by Lalitpur and Sindhuli districts. Production wise all of these districts have capacity to prepare *T.mairei* seedling/sapling annually up to 50,000.

Active nurseries of *Taxus mairei* located in Kavrepalanchok, Sindhuli and Lalitpur districts are engaged in the preparation of both cuttings and seedlings on a regular basis. Few nurseries operate on an intermittent basis, initiating seedling production only when there is sufficient market demand. This indicates a strong dependency on commercial viability, which affects the continuity of nursery activities. *T. mairei* nurseries of Kavrepalanchok, Lalitpur and Sindhuli possess the capacity and necessary conditions to produce *T. mairei* seedlings and saplings effectively, contributing to the regional supply when needed. Unfortunately, a *T. mairei* nursery established by the private initiative of a local medicinal plant trader in the Agara area of Makawanpur district was dismantled after operating for over five years, due to a lack of demand from the government and interested farmers. Such incidences resulted not only economic loss for the investor but also a setback for conservation efforts aimed at promoting the species' cultivation and sustainable use.

The plantation of *Taxus mairei* seedlings or saplings is primarily carried out with support from Division Forest Offices or by individuals interested in initiating commercial cultivation on private land. However, the consistent operation of *Taxus* nurseries and their capacity to produce healthy seedlings or saplings largely depend on market demand for *T. mairei* propagules. This demand is often uncertain and fluctuating, making it difficult to sustain nursery operations. As a result, many nurseries that are currently functional tend to be in suboptimal condition due to the lack of stable and predictable demand.

4.2 Challenges of *T. mairei* Nurseries in Bagmati Province

Sustainability of *T. mairei* nurseries in Bagmati Province are significantly constrained by a range of interrelated challenges, particularly stemming from the poor status of nursery management. These challenges compromise not only the productivity of plantation efforts but also the conservation value and commercial viability of the species. These nurseries are facing compounded effects of several challenges. Without immediate interventions such as establishing elite mother tree orchards, standardizing propagation protocols, improving nursery infrastructure, and instituting certification and traceability systems both the conservation objectives and commercial potential of *T. mairei* can not be exploited in its optimal level. Key challenges are discussed below.

1. Absence of Quality Planting Material

One of the most critical bottlenecks in the development of *T. mairei* nursery is the lack of genetically and chemically superior planting material. In all active nurseries across Lalitpur, Kavrepalanchok, Sindhuli, and Makawanpur districts, there is no access to verified elite genotypes or mother plants with known high concentrations of 10-deacetylbaccatin III (10-DAB), the valuable precursor to paclitaxel. The propagation material used in these nurseries is often collected from only one or two mature trees located nearby, resulting in genetic bottlenecks, reduced resilience, and unknown chemical yields in plantation stocks.

2. Dependency on Limited and Unverified Source Trees

The heavy reliance on a very limited number of *T. mairei* mother trees for vegetative propagation (cuttings) poses serious risks. This narrow genetic base affects the adaptability and long-term viability of planted populations. In Kavre district, for instance, there is also an alarming trend of mixing cuttings from *T. wallichiana* with those of *T. mairei* in nurseries, due to poor taxonomic identification and lack of field-level training. Such misidentification not only distorts the conservation mapping of the species but also affects the uniformity and efficacy of plantations for 10-DAB yield and pharmacological consistency.

3. Lack of Standardized Nursery Protocols

Across the province, there is an evident absence of standard protocols for *T. mairei* nursery operations. Nursery operators lack technical guidance on propagation methods, including whether clonal propagation (cuttings) or seed germination is most effective under Nepal's agro-ecological conditions. While cutting propagation is commonly practiced due to the ease of access to twigs, its success rates vary significantly, and seed-based propagation remains largely unexplored due to lack of documented trials. The lack of scientifically validated propagation guidelines results in inconsistent plant health, low survival rates, and suboptimal biomass production.

4. Inadequate Infrastructure and Minimal Facilities

Most *T. mairei* nurseries in Bagmati operate with bare minimum infrastructure. Essential components such as well managed green house, shaded propagation beds, misting systems, temperature regulation, rooting hormone application, and disease/pest control mechanisms are either missing or poorly managed. Such infrastructural deficiencies lead to low rooting success, weak seedlings, and high post-planting mortality. These limitations are especially acute in community-managed and farmer-run nurseries, which often function with limited technical and financial support.

5. Absence of Traceability and Record-Keeping

Another serious gap lies in the absence of proper documentation and traceability mechanisms in nurseries. Critical information such as the origin of planting material, identity and condition of mother plants, rooting success rates, seedling survival rates, and end-user (farmer or district) tracking is completely lacking. This hinders post-plantation monitoring and evaluation, making it impossible to assess the field performance of nursery-derived plants or improve propagation techniques based on feedback.

6. No Institutional Support for Community or Private Nurseries

Despite their role in promoting conservation and income generation, nurseries operated by private farmers or community forest user groups (CFUGs) receive minimal government support. There is no dedicated mechanism for capacity building, financial subsidy, or technical backup from provincial or federal forest agencies. As a result, many promising nurseries face operational discontinuity or closure, as seen in the case of the now-defunct nursery in Agara, Makawanpur. This lack of institutional backing discourages community-level engagement and investment in *T. mairei* propagation.

7. No Nursery Accreditation or Certification System

There is currently no official certification or quality assurance system in place for *T. mairei* nurseries in Nepal. As a result, farmers and CFUGs have no reliable means to assess whether seedlings they purchase are genetically pure, disease-free, or chemically viable. This regulatory vacuum also opens the door to the unintentional distribution of mixed or low-quality planting stock, further undermining plantation success and conservation outcomes.

4.3 Cultivation of *T. mairei*

The plantation of *Taxus mairei* in sacred sites, as well as in specific locations such as resting places along walking trails and ridgelines, has been a common traditional practice in Nepal. However, the cultivation of *Taxus* for commercial purposes particularly for taxol extraction gained significant momentum only after the widespread and uncontrolled harvesting of leaves from natural stands was restricted. By the time the commercial value of *Taxus* was fully recognized, over 60% of its wild populations had already been lost across their natural habitats. Systematic cultivation efforts began around the year 2000. Among the various species, *T. mairei* has emerged as the most widely planted in Nepal, particularly in Bagmati Province with the annual production of up to 120 ton dry leaves. The largest plantations are found in Lalitpur, followed by Sindhuli and Kavrepalanchok districts.

Table 4. Commercial farming of *T. mairei* in the Lalitpur, Kavre, Makawanpur and Sindhuli

SN	Farmers	District	Locality	Trees (approx)	Dry leaf Biomass (approx.)
1	Aadi Maya Thokar	Lalitpur	Mahakal-3	2500	70-100 tons
2	Badri Pradhan	Lalitpur	Mahakal-3	1000	
3	Bed Prashad Timilsina	Lalitpur	Mahakal-2	200	
4	Bedhnath Dahal	Lalitpur	Mahakal-7	100	
5	Beni Bahadur Timilsina	Lalitpur	Mahakal-3	1200	
6	Bhawanath Timilsina	Lalitpur	Mahakal-4	550	
7	Bhim Bahadur Waiba	Lalitpur	Mahakal-4	500	
8	Bhim Kumar Syangtan	Lalitpur	Mahakal-3	400	
9	Bhui Nanda Ghimire	Lalitpur	Mahakal-3	900	
10	Bijaya Ghalan	Lalitpur	Mahakal-3	300	
11	Birbal Lama	Lalitpur	Mahakal-4	500	
12	Buddha Bahadur Waiba	Lalitpur	Mahakal-4	100	
13	Chandr Bahadur Nyasur	Lalitpur	Mahakal-3	2500	
14	Chandra Bahadur Shrestha	Lalitpur	Mahakal-5	200	
15	Chandra Bahadur Timilsina	Lalitpur	Mahakal-3	200	
16	Chet Prashad Sapkota	Lalitpur	Mahakal-4	250	
17	Dal Bahadur Adhikari	Lalitpur	Mahakal-3	4800	
18	Deepak Thokar	Lalitpur	Mahakal-3	2000	
19	Del Bahadur Singtang	Lalitpur	Mahakal-3	2500	
20	Devendra Ghimire	Lalitpur	Mahakal-4	800	
21	Devi Prashad Ghimire	Lalitpur	Mahakal-5	2000	
22	Dhan Bahadur Timilsina	Lalitpur	Mahakal-3	150	
23	Dilli Prashad Sapkota	Lalitpur	Mahakal-4	650	
24	Dukman Singtang	Lalitpur	Mahakal-3	1000	
25	Ganga Prashad Timilsina	Lalitpur	Mahakal-3	5300	
26	Gem Nath Timilsina	Lalitpur	Mahakal-3	150	
27	Govinda Kumar Ghimire	Lalitpur	Mahakal-5	750	
28	Govinda Prashad Ghimire	Lalitpur	Mahakal-5	60	
29	Hem Prashad Sapkota	Lalitpur	Mahakal-3	400	
30	Hom Prashad Ghimire	Lalitpur	Mahakal-4	1500	
31	Indra Kumar Syangtan	Lalitpur	Mahakal-3	7100	
32	Indraman Waiba	Lalitpur	Mahakal-3	2200	
33	Ishwor Gautam	Lalitpur	Mahakal-4	560	
34	Jayaram Dahal	Lalitpur	Mahakal-6	100	
35	Khang Dorje Syangtang	Lalitpur	Mahakal-3	500	
36	Krishna Bahadur Shrestha	Lalitpur	Mahakal-5	50	

SN	Farmers	District	Locality	Trees (approx)	Dry leaf Biomass (approx.)
37	Kuber Pradhan	Lalitpur	Mahakal-3	350	
38	Kul Bahadur Timilsina	Lalitpur	Mahakal-3	200	
39	Lok Bahadur Nyasur	Lalitpur	Mahakal-3	500	
40	Makhamali Waiba	Lalitpur	Mahakal-4	20	
41	Menuka Thokar	Lalitpur	Mahakal-3	200	
42	Mith Ram Dahal	Lalitpur	Mahakal-5	100	
43	Nandhalal Ghimire	Lalitpur	Mahakal-4	210	
44	Niraj Sapkota	Lalitpur	Mahakal-5	200	
45	Ol Prashad Timilsina	Lalitpur	Mahakal-3	1500	
46	Pampha Thokar	Lalitpur	Mahakal-5	200	
47	Prem Bahadur Ghimire	Lalitpur	Mahakal-4	1000	
48	Punya Prashad Sapkota	Lalitpur	Mahakal-5	2250	
49	Rabin Ghimire	Lalitpur	Mahakal-5	40	
50	Rajan Chaulagai	Lalitpur	Mahakal-4	200	
51	Rajkumar Dulal	Lalitpur	Mahakal-5	200	
52	Ram Bahadur Pradhan	Lalitpur	Mahakal-3	200	
53	Ram Bahadur Syangtang	Lalitpur	Mahakal-3	600	
54	Ram Bahadur Waiba	Lalitpur	Mahakal-4	200	
55	Ram Hari Timilsina	Lalitpur	Mahakal-3	1200	
56	Ram Kumar Chaulagai	Lalitpur	Mahakal-3	1500	
57	Ram Kumar Negi	Lalitpur	Mahakal-3	2700	
58	Ramkrishna Thokar	Lalitpur	Mahakal-4	360	
59	Sanchaman Syangtang	Lalitpur	Mahakal-4	400	
60	Santalal Lama	Lalitpur	Mahakal-4	1200	
61	Shambhu Prashad Prasai	Lalitpur	Mahakal-5	200	
62	Singbir Syangtang	Lalitpur	Mahakal-3	2500	
63	Som Bahadur Thokar	Lalitpur	Mahakal-3	700	
64	Som Gole	Lalitpur	Mahakal-3	2300	
65	Sukram Waiba	Lalitpur	Mahakal-4	200	
66	Surya Bahadur Gole	Lalitpur	Mahakal-4	250	
67	Thal Prashad Dahal	Lalitpur	Mahakal-4	200	
68	Tuk Prashad Ghimire	Lalitpur	Mahakal-4	825	
69	Udhav Prashad Timilsina	Lalitpur	Mahakal-3	2000	
70	Uttam Ghimire	Lalitpur	Mahakal-5	350	
71	Yeggya Bahadur Adhikari	Lalitpur	Mahakal-3	1000	
72	Yiman Singh Singtang	Lalitpur	Mahakal-3	950	
73	Jeevan	Lalitpur	Badhikhel	1000	
74		Lalitpur	Badhikhel	500	
75	Anil Tamang	Makawanpur	Tistung	100	1 ton

SN	Farmers	District	Locality	Trees (approx)	Dry leaf Biomass (approx.)
76	Sonam Tamang	Makawanpur	Tistung-Deorali	200	
77	Shri Sundari Devi HSS	Makawanpur	Dadabas	700	
78	Pratap Gole	Makawanpur	Dadabas	100	
79	Arjun Prashad Timilsina	Kavrepalanchok	Dhungkharka		Up to 5 tons
80	Bhim Prashad Timilsina	Kavrepalanchok	Dhungkharka		
81	Ekanidhi Ghimire	Kavrepalanchok	Dhungkharka		
82	Gopal Prashad Timilsina	Kavrepalanchok	Dhungkharka		
83	Kanchha Shrestha	Kavrepalanchok	Dhungkharka		
84	Krishna Prashad Timilsina	Kavrepalanchok	Dhungkharka		
85	Kul Prashad Timilsina	Kavrepalanchok	Dhungkharka		
86	Maure Dahal	Kavrepalanchok	Dhungkharka		
87	Min Raj Timilsina	Kavrepalanchok	Dhungkharka		
88	Prem Bahadur Timilsina	Kavrepalanchok	Dhungkharka		
89	Ram Bahadur Timilsina	Kavrepalanchok	Dhungkharka		
90	Ram Prashad Nepal	Kavrepalanchok	Dhungkharka		
91	Ambar Bahadur Karki	Sindhuli	Fikkal		Annual 15-20 tons
92	Ashok Magar	Sindhuli	Fikkal		
93	Bel Bahadur Budhathoki	Sindhuli	Fikkal		
94	Bhakta Bahadur Sunuwar	Sindhuli	Fikkal		
95	Bishnu Bahadur Sunuwar	Sindhuli	Fikkal		
96	Chandra Kumari B.K.	Sindhuli	Fikkal		
97	Chhabi Bahadur B.K.	Sindhuli	Fikkal		
98	Deepak Kafle	Sindhuli	Fikkal		
99	Ganesh Bahadur Budhathoki	Sindhuli	Fikkal		
100	Hari Bhattarai	Sindhuli	Fikkal		
101	Hari Budha Chhetri	Sindhuli	Fikkal		
102	Hom Bahadur Sunuwar	Sindhuli	Fikkal		
103	Indra Prasad Bhattarai	Sindhuli	Fikkal		
104	Indra Tamang	Sindhuli	Fikkal		
105	Jhaindra Bahadur Budhathoki	Sindhuli	Fikkal		
106	Jiwan Bhattarai	Sindhuli	Fikkal		
107	Keshar Bahadur Sunuwar	Sindhuli	Fikkal		
108	Lalit Bhattarai	Sindhuli	Fikkal		
109	Maan Bahadur Tamang	Sindhuli	Fikkal		
110	Madhu Sunuwar	Sindhuli	Fikkal		
111	Mahendra Bahadur Sunuwar	Sindhuli	Fikkal		

SN	Farmers	District	Locality	Trees (approx)	Dry leaf Biomass (approx.)
112	Mit Bahadur Tamang	Sindhuli	Fikkal		
113	Mohan Bahadur Karki	Sindhuli	Fikkal		
114	Padam Bahadur Karki	Sindhuli	Fikkal		
115	Phaudh Singh Tamang	Sindhuli	Fikkal		
116	Purna Tamang	Sindhuli	Fikkal		
117	Ratna Maya Tamang	Sindhuli	Fikkal		
118	Rudra Bahadur Magar	Sindhuli	Fikkal		
119	Rudra Bahadur Sunwar	Sindhuli	Fikkal		
120	Rudra Tamang	Sindhuli	Fikkal		
121	Sanman Tamang	Sindhuli	Fikkal		
122	Som Bahadur Tamang	Sindhuli	Fikkal		
123	Tek Bahadur Bhattarai	Sindhuli	Fikkal		
124	Tulke Tamang	Sindhuli	Fikkal		
125	Tek Bahadur Tamang	Sindhuli	Fikkal		

5. Uses, Traditions, and Trade Dynamics of *T. mairei*

5.1 Traditional and Commercial Uses

Yew trees are globally recognized for their diverse and valuable contributions to human well-being. In Nepal, all three native yew species hold immense ecological, medicinal, cultural, and economic significance. These species play a vital role in traditional healing systems, spiritual practices, and local livelihoods, especially across the Himalayan regions where they naturally occur. Due to their wide-ranging utility, Himalayan yews have been extensively harvested and utilized over the years. The following sections provide a comprehensive overview of traditional and commercial uses, cultural importance, and the trade patterns associated with *Taxus mairei* in Nepal.

5.2 Traditional Medicine

Yews are extensively used by local communities of Bagmati province since long time. Various parts of Himalayan yews are utilized in traditional medicine systems. Poudel et al. (2013) catalogue range of traditional uses of yews including that of *T. mairei*. Leaves and bark are used to treat fever, colds. Coughs, bronchitis, and rheumatism. Bark paste is applied externally for headaches and muscle pains. The high altitude species are used by the local communities to prepare tea. Traditional uses of yews range from traditional medicine, timber, thatching and many more.

5.3 Timber and Other Uses

In high altitude areas the wood of yews is considered as most durable and strong. High altitude communities compare the wood of yews to the low altitude timber species 'Shorea robusta'. Some locals also regarded *Taxus* as high altitude 'Sal'. The wood of *T. mairei* has multiple applications. Traditionally the wood was used in Temple, Monastery and houses construction. Mainly the door frames, and structural components in houses are made by the

Yew wood. In past local people of some area used taxus wood to make furniture. Various traditional tools and agriculture implements are made of Taxus wood. The inner bark yields a red dye, which is used to color cloths and other stuffs.

5.4 Cultural Significance

T. mairei has strong cultural and religious value for the local communities living across the distribution range of this species. Large yew trees are often found near temples and monasteries, considered sacred and protected.

Similarly, Buddhist communities living around the natural distribution of *T. mairei* make drums made from yew wood, which when played help to chase evil spirit.



Figure 16. Musical instrument prepared using the wood of *T. mairei*, which the local shamans use during spiritual practices.



Figure 17. Tree on left protected in Chalal Ganesh (Kavre) and right protected in Dandabas (Makawanpur)

Branches are used during Bajrabarahi Mela, a sacred festival happens in a cycles of every three years. During the festival locals mostly collect leaves of *T. mairei* from Chulipran Community Forest and decorate the Bajrabarahi temple as shown on the figure below.



Figure 18. Left: Goddess Bajrarahis' temple and her idol were decorated by the leaves of *T. mairei*. Right: Tamang people using *T. mairei* leaves during naming ceremony. (Source of both images, Bhatta et al. 2017)

6. Taxus, Taxol and processing

In 1950s United States National Cancer Institute (NCI) began a large-scale natural product screening initiative. This program aimed to explore plant biodiversity for potential chemotherapeutic agents. In August 1962, as part of this initiative, botanists from the United States Department of Agriculture (USDA) collected bark samples from the Pacific yew tree (*Taxus brevifolia*) in Washington State. The samples, labeled under the code NSC 125973, were submitted to the NCI for biological screening.

In the late 1960s, researchers at the Research Triangle Institute in North Carolina, led by Dr. Monroe E. Wall and Dr. Mansukh C. Wani, successfully isolated an active compound from these bark extracts. This compound demonstrated strong cytotoxic activity against cancer cells and was named "Taxol," reflecting its origin from the *Taxus* genus. In 1971, the researchers elucidated its complex chemical structure, identifying it as a highly oxygenated diterpenoid with a unique taxane ring system.

The significance of Taxol grew even further in 1979 when Dr. Susan B. Horwitz and her team at the Albert Einstein College of Medicine discovered its novel mechanism of action. Unlike other chemotherapeutic agents that inhibit microtubule formation, Taxol binds to microtubules and stabilizes them, preventing their depolymerization. This leads to the inhibition of cell division and effectively halts cancer cell proliferation, marking a unique mode of action that set Taxol apart from existing drugs.

Despite its promising anticancer activity, the clinical development of Taxol faced significant challenges due to its limited natural supply. The extraction of 1 gram of Taxol required over 30 pounds of *T. brevifolia* bark, resulting in environmental concerns and prompting a search for sustainable alternatives. Nevertheless, clinical trials progressed through the 1980s, and Bristol-Myers Squibb acquired the rights to develop and commercialize the drug. In 1992, Taxol received approval from the U.S. Food and Drug Administration (FDA) for the treatment of ovarian cancer, followed by approvals for breast cancer, non-small cell lung cancer, and

Kaposi's sarcoma. To address sustainability and supply issues, researchers turned to semi-synthetic production methods using 10-Deacetylbaaccatin III (10-DAB), a compound found in the leaves and twigs of various *Taxus* species such as *T. baccata*, *T. wallichiana* and *T. mairei*. This approach allowed for the continued production of paclitaxel without relying on destructive bark harvesting.

6.1 Trade and Commercialization of *Taxus* in the Himalaya

The use of Himalayan yews for the extraction of Taxol (paclitaxel) or its key precursor 10-Deacetylbaaccatin III (10-DAB), began in the late 1980s to early 1990s. This shift followed the discovery and clinical validation of paclitaxel's potent anticancer properties, in the United States during the 1960s. At that time, the Himalayan yew species had not yet been explored for their chemical constituents. However, as clinical trials progressed and paclitaxel was approved by the U.S. FDA in 1992 for ovarian cancer treatment, demand for the compound rose dramatically, exposing the unsustainable nature of relying solely on *T. brevifolia*, a slow-growing and limited species.

In response to this challenge, researchers began investigating other *Taxus* species across Asia and Europe. By the late 1980s and early 1990s, studies confirmed that Himalayan species contained measurable quantities of 10-DAB, particularly in their leaves and twigs. Unlike bark extraction, which typically kills the tree, leaf harvesting offered a more sustainable, renewable method of sourcing the compound. This discovery was particularly significant for countries in the Himalayan region, including Nepal, India, Bhutan, and parts of China, where these species occur naturally.

6.2 Trade Dynamics of *T. mairei* Leaves for 10-DAB Isolation

In the mid-1990s, Dabur Nepal, initially a subsidiary of Dabur India, secured a government license to collect leaves and small twigs of *Taxus* from natural forests in Nepal for the extraction of paclitaxel precursors. The company exported these crude materials to licensed pharmaceutical processors abroad, most notably Dabur India, which partnered with firms in Italy and the USA to convert them into active compounds like 10-deacetylbaaccatin III (10-DAB) and paclitaxel. Nepal's domestic processing capacity began to emerge later: by the early 2000s, Machhapuchhre Herbal Pvt. Ltd. in Hetauda initiated pilot-scale production, processing Nepal-grown *Taxus* leaves to yield pharmaceutical-grade intermediates, though production was inconsistent.

Another key player in the commercialization of Taxol in Nepal is Evans Life Sciences Private Limited (previously known as "Natural Flower and Herbal Private Limited"). Evans is a privately owned entity with expertise in extraction and purification of Phyto-chemicals. The company initially entered into an exclusive agreement with Dabur India to supply *Taxus* (Himalayan yew) as raw biomass for the production of 10-Deacetylbaaccatin III (10-DAB III), a key intermediate in the synthesis of the anti-cancer drugs **paclitaxel** and **docetaxel**. For six years, it served as a biomass supplier to Dabur. However, the company later obtained a license from the Government of Nepal to independently process *Taxus* and to export the concentrated methanolic extract. After Evans established its own processing facility in Nepal, Dabur discontinued its involvement in Taxol production using Nepalese *Taxus* resources.

While Nepal has considerable potential—estimated at over 2,000 kg of 10-DAB annually commercial-scale synthesis still largely depends on collaboration with Indian and international pharmaceutical firms. The extraction process involved drying, milling, solvent extraction, and purification—producing high-purity 10-DAB III (~99.4%) via methods like HPLC and crystallization. Licensed to extract up to 600 kg of 10-DAB III annually, the Evans spearheaded R&D and processing of Himalayan yew leaves and twigs, positioning itself as the largest producer of this intermediate in Nepal. Though primarily exporting its 10-DAB III to neighboring markets like India and China, Evans laid the groundwork for Nepal's participation in the global paclitaxel supply chain. Through domestic capacity-building and licensing, it helped shift Nepal from mere raw-leaf supplier to active processor—albeit full-scale paclitaxel synthesis still relies on international partners specializing in semi-synthetic conversion.

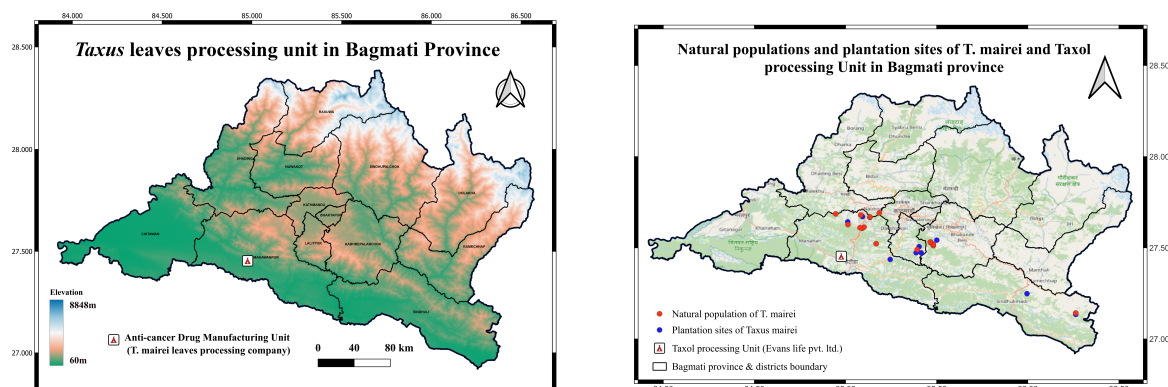


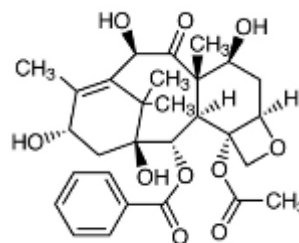
Figure 19. *Taxus* leaves processing unit (left) and *T. mairei* plantations sites and natural populations (right)

6.3 Trade Route of *T. mairei* leaves and the 10 DAB-III in Nepal

The collection of *T. mairei* leaves is governed by national forest regulations due to the plant's endangered status and its listing under Appendix II of the CITES. Private Nepali companies engaged in the extraction and processing of plant-based medicinal compounds are eligible for licensing, provided they demonstrate technical capacity and compliance with national regulations. According to CITES Act 2019, either Paclitaxel can be manufactured within the country and export the final product in drug form or crude export the crude 10-DAB III in the powder form.

10-Deacetyl Baccatin-III

Chemical Formula: $C_{29}H_{36}O_{10}$ Mol.Wt: 544.59 g/mol
CAS No:32981-86-5



6.4 10-DAB Manufacturing Process

Extraction

- *Taxus mairei* leaves are collected from plantation sites, shade dried and transported to the processing unit
- Leaves are subjected to extraction with methanol until complete extraction of 10 DAB III. Once the extraction is over, the extract is heated under vacuum to

concentrate the extract.

Isolation

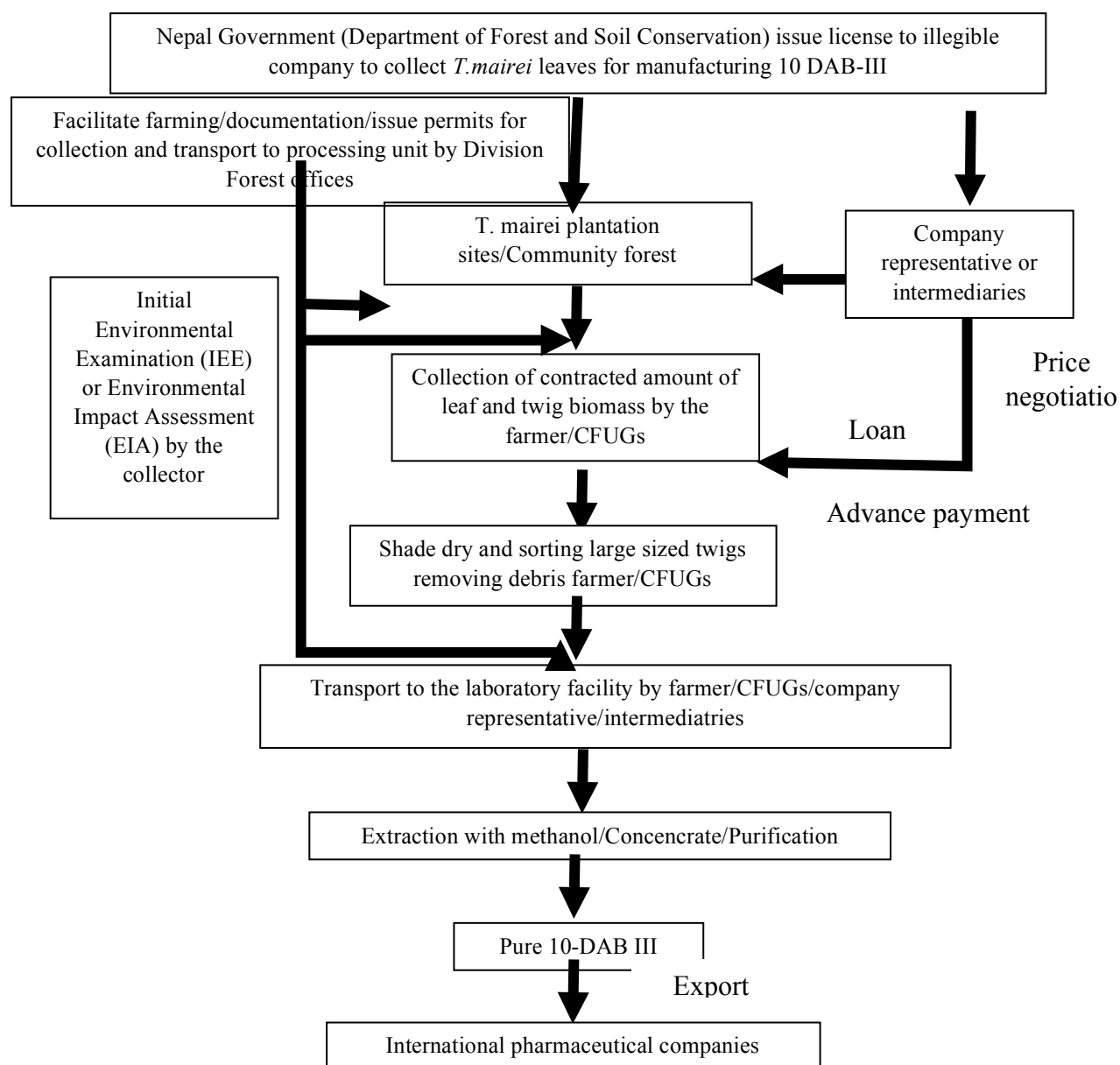
- The concentrate is mixed with water to remove resinous substance followed by filtration.
- The filtrate is washed with various solvents and crystallized to form Crude 10 DAB III.

Purification

- The crystals of 10-DAB III under goes a series of purification steps to obtain 99% pure 10-DABIII.

6.5 Manufacturing 10-DAB III and Trade Route

The following diagram shows the trade route of Tm after processing through 10-DAB.



7. Conservation Practices and Regulations

7.1 Fate of Nepalese Yew Populations

Following the global recognition of paclitaxel (Taxol) as an effective anticancer compound in the early 1990s, demand for *Taxus* species surged dramatically. The Himalayan yew, which contains significant amounts of paclitaxel and its precursor compounds, became a major target for harvesting. In many parts of Nepal, India, and Bhutan, collectors began extracting bark and leaves in large quantities for pharmaceutical use, often without regulatory oversight. Uncontrolled harvesting and destructive collection methods further accelerated the decline of hundreds of the natural population of yews in the Himalaya including in Nepal. Instead of employing sustainable techniques, harvesters frequently removed large branches severely damaging or killing them. Such methods did not allow for natural regeneration and led to long-term degradation of yew populations. At the same time, yew trees, which thrive in dense broad leaved high-altitude forests, were increasingly threatened by habitat loss. Deforestation for agriculture, overgrazing by livestock, infrastructure development, and logging have all contributed to the fragmentation and shrinking of suitable habitats for yew regeneration. Therefore, the decline and local extinction of natural populations of yews in Nepal can be attributed to a combination of overexploitation, habitat degradation, and lack of sustainable management.

Nepal was depended entirely on wild populations for leaf and bark collection, with little knowledge of sustainable alternatives. Conservation efforts on Himalayan yews have been hampered by weak enforcement of protective regulations. Illegal harvesting and trade of yew materials have continued in many remote areas due to insufficient monitoring and cross-border control. In the initial stage, the lack of awareness among government authorities, conservationist and local communities about the ecological importance of yews and the absence of organized cultivation or replanting initiatives further exacerbated the situation. Between 1990 and 2005, Nepal experienced a significant decline in several natural populations of yew trees due to overharvesting and habitat degradation. Ironically, during this period, the scientific community in the Himalayan region—including Nepalese botanists—lacked clear knowledge about the number of *Taxus* species occurring naturally in the Himalayas and their precise distribution ranges. It was not until 2012 that a comprehensive and robust study by Poudel et al. clarified the taxonomic identity and distribution of Himalayan yews, revealing the presence of three distinct species in the region: *Taxus contorta*, *Taxus wallichiana*, and *Taxus mairei*.

The conservation and sustainable utilization of yew species (*Taxus* spp.) in Nepal are embedded within the country's broader forest and biodiversity conservation frameworks. Yews, particularly the three species (*T. contorta*, *T. mairei* and *T. wallichiana*,) are of critical importance due to their endangered status and commercial value in the production of anti-cancer compounds like paclitaxel and 10-deacetylbaccatin III (10-DAB). In response to overharvesting and population decline, the Government of Nepal has implemented a multi-tiered system of regulations and conservation interventions involving federal, provincial, and local governments.

7.2 Federal-Level Regulations and Interventions

At the federal level, the Ministry of Forests and Environment (MoFE) is the primary body responsible for forest conservation and environmental regulation. The Forest Act 2019 (2076) and the Forest Regulation 2022 (2079) provide the legal basis for managing forest resources, including yews. These laws regulate the extraction, trade, and processing of forest products through licensing systems and sustainable harvest quotas. The Environment Protection Act 2019 (2076) and its accompanying Environmental Protection Rules 2020 (2077) also require environmental assessments—Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA)—for commercial harvesting and processing of yew leaves. Furthermore, *Taxus* species are listed as a protected plant under Forest Regulation, meaning its collection and trade are highly restricted. *T. mairei* is also included in Appendix II of CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), obligating the government to monitor and control international trade through the issuance of CITES permits. The Department of Plant Resources (DPR) and the Department of Forests and Soil Conservation oversee these technical and regulatory aspects.

7.3 CITES Act 2017 and Regulation 2019

The CITES Act 2017 and CITES Regulations 2019 of Nepal play a crucial role in ensuring the conservation and sustainable trade of all the three species of *Taxus* including *T. mairei*. These legal instruments were developed in alignment with Nepal's obligations under the CITES, to which Nepal has been a party since 1975. The inclusion of yews in Appendix II of CITES requires member countries to regulate international trade in a way that does not threaten the species' survival. The Act and accompanying regulations provide the legal framework to fulfill these commitments.

The CITES Act, 2017 (2074 B.S.) was enacted to give domestic legal force to Nepal's CITES obligations. It empowers the Government of Nepal—through the Ministry of Forests and Environment (MoFE)—to regulate, monitor, and control the trade of CITES-listed species, including yews. Under this Act, *Taxus* and its derivatives (such as leaves, bark, and processed compounds like 10-DAB) cannot be exported or imported without a valid CITES permit issued by the CITES Management Authority, designated as the MoFE. This Act is particularly relevant to the yew trade, as it provides the legal basis to scrutinize and control the export of yew leaves, crude extracts, or any taxol intermediates, ensuring that only sustainably harvested and traceable materials are traded.

7.4 Non-Detriment Finding (NDF)

International trades of species listed in CITES appendices only occur if the given is non-detrimental to the long term survival of the species. The scientific authority of CITES conducts comprehensive survey and based on the available data they make decision. Such document is called a non-detriment finding (NDF). NDF should prepare Non-detrimental finding (NDF) reports of each traded species based on the biology, conservation status, trade levels and harvest management of the species. NDF includes export quota of the species which will not be detrimental for its survival.

7.5 Provincial, Local and Community Involvement

Provincial and local level governments have crucial role in the conservation and sustainable use of *T. mairei*. Community Forest User Groups (CFUGs) are actively engaged in the management and conservation of yew populations. These groups operate under operational plans approved by division forest offices, which must explicitly include conservation measures for sensitive species. CFUGs are responsible for monitoring yew populations, enforcing sustainable harvesting guidelines (e.g., collecting only leaves and twigs, not bark or roots), and implementing cultivation programs. Local governments, especially rural municipalities and wards, also participate in conservation efforts by facilitating awareness campaigns, supporting local biodiversity inventories, and coordinating with provincial and federal agencies.

Table 4. Conservation strategies

SN	Conservation initiatives	Area	Implementation agency
1	Sisban area was declared 'Taxus Pocket' area in 2077/078		Division forest office /Mahakal Rural Municipality, Lalitpur
2	Plan to establish processing unit in 2077/078		Division forest office /Mahakal Rural Municipality, Lalitpur
3	Risheswor Community forest was declared T. mairei Germplasm Preservation area		
4	Chulipran Community forest was also declared T. mairei germplasm preservation area	Chulipran CF	Division forest office /Chulipran Community Forest, Makawanpur
5	T. mairei pocket area (Wild stock protection and cultivation)	Phikkal Rural Municipality 1, Mahadevdanda and Majkharka; Sangli Tinchamke CF,	Phikkal Rural Municipality/



8. Challenges and Strategic Action Plans

8.1 Threats and Challenges

Over the past decade, Nepal has made remarkable progress in the conservation and sustainable use of yew species, particularly *Taxus mairei* in Bagmati province. This progress has been driven by the concerted efforts of the Government of Nepal, community forest user groups (CFUGs), local communities, and medicinal plant farmers, who now have valuable experiences and success stories to share with the international conservation community. A significant milestone in this journey has been the implementation of the CITES Act (2017), which was enacted to strengthen the country's compliance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). To further operationalize this legislation, the CITES Regulations (2019) were introduced to address legal ambiguities and promote the sustainable trade of CITES-listed species, including *T. mairei*. These legal instruments not only support biodiversity conservation but also contribute to improving the livelihoods of rural communities engaged in medicinal plant cultivation.

The Department of Forests and Soil Conservation and the Department of Plant Resources have played vital roles in preparing Non-Detriment Findings (NDFs) for *T. mairei*, a critical requirement for the legal trade of CITES-listed species. In parallel, division forest offices have provided continuous support and technical guidance to community forest user groups and local farmers, particularly in Bagmati Province, thereby encouraging the cultivation and expansion of *T. mairei* farming.

Despite these significant achievements, several challenges remain. Addressing these requires enhanced coordination and collaboration among stakeholders, including government bodies, local communities, researchers, and private sector actors, to ensure the long-term sustainability of yew conservation and trade in Nepal. The following section presents a brief overview of the primary challenges currently facing this sector.

8.1.1 Slow Growth Rate and Poor Natural Regeneration

A critical biological challenge lies in the slow growth rate and poor natural regeneration of yews. These species are shade-tolerant and slow-growing conifers, and their populations require many years to recover after exploitation.

One of the most significant biological constraints to the sustainable management of *Taxus mairei* and other yew species distributed in Nepal is their inherently slow growth rate and poor natural regeneration capacity. As shade-tolerant and late-successional conifers, yews exhibit slow vegetative and reproductive development. In the wild condition, even when seeds are produced, germination rates are typically low, and seedlings require very specific microhabitat conditions such as moist, shaded forest floors with minimal disturbance to establish and survive. All the natural populations of *T. mairei* in Bagmati province lack regeneration. Therefore, these populations are not suitable for commercial harvesting at least for their current ecological conditions. When the ecological health of their natural habitat is improved in future, commercial harvesting can be planned in that time.

8.1.2 Unsustainable Harvesting Techniques

One of the most pressing challenges to the conservation of *Taxus mairei* in Nepal has been the widespread practice of unsustainable harvesting. Over the past few decades, the increasing demand for paclitaxel and its precursor, 10-deacetylbaccatin III (10-DAB), has led to intense extraction pressure on natural yew including *T. mairei*. In many cases, harvesting was conducted without regard for sustainable yield limits, resulting in the overexploitation of nearly all existing wild populations. Collectors, driven by market demand often resorted to destructive methods, such as cutting entire branches and debarking such practices that severely compromise the plant's survival and regeneration potential.

The consequences of such practices are particularly severe given the slow growth rate and poor regenerative capacity of yew species. Populations subjected to overharvesting are unlikely to rebound without significant conservation intervention.

A contributing factor to the continuation of unsustainable harvesting practices is the lack of awareness and technical knowledge at the grassroots level. While Community Forest User Groups and the effort of leading farmers have been central to forest management and conservation, many lack the species-specific knowledge and training required to manage yew resources sustainably. Limited access to best-practice guidelines, and the absence of routine monitoring exacerbate the problem. As a result, even well-intentioned harvesting efforts often lead to unintended ecological harm. Addressing this issue requires focused efforts in capacity building, awareness-raising, and the introduction of non-destructive harvesting methods, such as selective leaf plucking and rotational harvesting, supported by research and policy.

8.1.3 Lack of Research on Ecology, Population Dynamics, and Habitat Fragmentation

Despite the ecological and commercial significance of *Taxus mairei*, there remains a critical lack of comprehensive research on its ecology, population dynamics, and response to habitat fragmentation. Most existing studies are limited in scope and geographic coverage, leaving significant knowledge gaps regarding reproductive biology, seed dispersal mechanisms, and regeneration patterns under varying ecological conditions. The impact of habitat fragmentation—caused by deforestation, infrastructure development, and land-use change—on gene flow and population viability has not been adequately assessed. Without such baseline ecological data, it is difficult to develop effective conservation strategies or assess the long-term sustainability of current harvesting and cultivation practices. Therefore, targeted ecological studies are urgently needed to inform evidence-based policy and management decisions.

8.1.4 Lack of Quality Planting Material

A major constraint in the large-scale cultivation and sustainable utilization of *T. mairei* is the absence of quality planting material. To date, no systematic experiments or breeding programs have been undertaken in Nepal to develop genetically superior planting stock with known levels of paclitaxel or 10-deacetylbaccatin III (10-DAB) content. As a result, both the productivity and chemical yield of cultivated yews remain largely unknown. This lack of standardized, high-quality propagules severely limits the potential for establishing high-yield plantations that are both economically viable and ecologically sustainable.

In many community-based initiatives and farmer-led plantations, propagation is commonly carried out using cuttings from a limited number of mother trees, often selected based on accessibility rather than genetic or chemical profiling. This practice leads to narrow genetic diversity, which not only reduces resilience to pests, diseases, and environmental stress but also increases the risk of long-term failure in plantation sustainability. Moreover, there is little to no knowledge or documentation on optimized nursery techniques, rooting success rates, or best planting practices tailored to different agroecological zones.

The lack of standardized protocols and access to superior planting material has created inconsistencies in growth performance and biomass yield across plantations. Addressing this challenge requires a concerted research effort to identify elite genotypes, evaluate 10-DAB content, and develop region-specific propagation and cultivation guidelines. Establishing clonal orchards, tissue culture protocols, and community-based nurseries supported by scientific institutions could be critical steps toward enhancing the overall productivity and sustainability of *T. mairei* plantations in Nepal.

8.1.5 Lack of Data on Optimized Harvesting Techniques for High 10-DAB Yield

One of the critical limitations in the sustainable and efficient utilization of *Taxus mairei* is the lack of scientific data and guidelines on optimized harvesting techniques aimed at maximizing 10-deacetylbaccatin III (10-DAB) yield. Despite the economic value of 10-DAB as a key precursor for the production of the anticancer drug paclitaxel, there is no established baseline information on the optimal harvesting time, the minimum quality or quantity of biomass required, or the specific parts of the plant that yield the highest concentrations of the compound.

This knowledge gap results in inconsistent and often inefficient harvesting practices across different regions. For example, in the absence of data on seasonal variation in 10-DAB content, leaf and twig biomass may be harvested at suboptimal times, leading to lower chemical yields and wastage of resources. Furthermore, there are no clear protocols on how to properly conduct harvesting in a non-destructive manner, nor on how to handle, store, and transport the collected biomass to preserve its chemical integrity.

In many cases, improper drying, long transport times without preservation, and exposure to heat or moisture during handling can significantly degrade the bioactive compounds, reducing the effectiveness and commercial value of the biomass. The lack of infrastructure, such as drying sheds, sealed transport units, and temperature-controlled storage, further exacerbates this issue in rural collection centers. To address these challenges, scientific studies are urgently needed to determine the ideal harvesting windows, identify plant parts with the highest 10-DAB concentration, and set thresholds for minimum biomass quality. In addition, the development of standardized harvesting, post-harvest handling, and transport protocols backed by training and awareness programs for community harvesters and local processors will be essential to ensure both sustainability and efficiency in the value chain of *T. mairei* for taxol production.

8.1.6 Lack of Appropriate Commercialization Strategies

Despite the increasing recognition of *T. mairei* including other two species of yew as a high-value medicinal resource, Nepal continues to face substantial challenges in developing effective commercialization strategies that are inclusive, equitable, and economically beneficial for all stakeholders. One of the most critical issues lies in the inability of local communities to supply high-quality leaf biomass consistently, primarily due to a lack of access to superior planting material, proper cultivation practices, and knowledge of optimal harvest timing and post-harvest handling techniques. As a result, the supply chain often fails to meet the quality standards required by processors and exporters, thereby limiting the competitiveness of Nepalese taxus material in national and international markets.

Furthermore, local farmers and community forest user groups (CFUGs) typically operate in a highly disadvantaged position within the value chain. They lack the technical capacity and market knowledge needed to negotiate fair prices for their produce. In the absence of price transparency and market alternatives, many producers are forced to accept low prices offered by a small number of processing companies that often dominate the market, leading to a de facto monopoly on leaf pricing. This not only undermines local livelihoods but also discourages the adoption of sustainable harvesting and cultivation practices.

In addition, while Nepal has developed capacity for the extraction of 10-deacetylbaicatin III (10-DAB), the country lacks the advanced technological infrastructure and regulatory frameworks needed to complete the value chain and manufacture the final anticancer product—paclitaxel or docetaxel—domestically. Consequently, the majority of high-value bioproducts are either exported in crude or semi-processed forms, or the raw materials are sold to international pharmaceutical companies that capture the bulk of the value addition.

Equally concerning is the government's limited role in facilitating an enabling environment for the commercialization of *T. mairei* based products. There has been insufficient policy support to attract investment in high-end processing facilities, inadequate market linkage initiatives, and a lack of incentives for both private sector engagement and community-level entrepreneurship. The absence of an integrated commercialization strategy, one that aligns community interests, conservation goals, industry needs, and export potential; continues to hinder Nepal's ability to fully benefit from the sustainable utilization of its rich *Taxus* resources.

Addressing these commercialization challenges will require multi-stakeholder coordination, investments in capacity-building, policy reforms to ensure price fairness and equity, and the development of robust domestic processing industries capable of producing and marketing high-value derivatives such as paclitaxel in both local and international markets.

8.2 Strategic Framework for *T. mairei* Conservation and Sustainable Use

1. Slow Growth Rate and Poor Natural Regeneration

Strategy: Enhance species recovery by promoting ecological studies, assisted natural regeneration, and propagation interventions.

Expected Outputs:

- Improved seedling establishment in natural habitats.
- Increased availability of healthy planting materials.
- Identification of ecological barriers to regeneration.

Actions:

- Conduct ecological studies on germination and seedling survival.
- Establish natural germplasm protection zones in each natural regeneration patches of *T. mairei*
- Develop propagation protocols using seeds and cuttings.
- Launch regeneration incentive schemes in community forests.

2. Unsustainable Harvesting Techniques

Strategy: Promote sustainable and species-specific harvesting practices through guidelines, capacity building, and community engagement.

Expected Outputs:

- Reduced damage to natural and planted populations during biomass collection.
- Trained community members and harvesters in best practices.
- Monitoring systems established for harvest sustainability.

Actions:

- Develop and distribute illustrated harvesting manuals.
- Conduct training programs for CFUGs and harvesters on non-destructive techniques.
- Introduce community-level harvest monitoring and reporting tools.
- Promote certification schemes for sustainably harvested material.

3. Lack of Research on Ecology, Population Dynamics, and Habitat Fragmentation

Strategy: Strengthen scientific research and data collection on the distribution, population trends, and habitat fragmentation of *T. mairei*.

Expected Outputs:

- Detailed ecological profiles and habitat maps of natural populations.
- Population viability assessments completed.

Actions:

- Conduct GIS-based mapping of each naturally grown *T. mairei* trees
- Establish permanent ecological monitoring plots in each natural patches
- Analyze the effects of fragmentation on gene flow and regeneration.
- Collaborate with universities for long-term ecological research.

4. Lack of Quality Planting Material

Strategy: Establish genetic resource conservation programs and quality-assured nursery systems to ensure supply of superior planting stock.

Expected Outputs:

- Selection and cloning of high-yielding genotypes.
- Community nurseries equipped to produce high-quality seedlings.
- Field trials established to evaluate performance of planting materials.

Actions:

- Screen and document elite genotypes for high 10-DAB content.
- Establish national clonal banks and gene conservation stands.
- Provide technical support to CFUGs for nursery management.
- Develop certification protocols for planting material quality.

5. Lack of Data on Optimized Harvesting Techniques for High 10-DAB Yield

Strategy: Generate evidence-based knowledge on harvest timing, biomass quality, and post-harvest processing to maximize 10-DAB recovery.

Expected Outputs:

- Seasonal and anatomical variation of 10-DAB concentrations documented.
- Protocols established for biomass collection, drying, and storage.
- Increased yield efficiency from the same volume of harvested material.

Actions:

- Conduct field and lab trials to determine peak 10-DAB accumulation periods.
- Standardize sampling and analytical methods for 10-DAB estimation.
- Train processors in optimal drying and transport methods.
- Develop digital tools for harvest timing alerts based on weather and phenology.

6. Lack of Appropriate Strategies for Commercialization

Strategy: Develop equitable, transparent, and value-addition oriented commercialization models involving communities, industries, and regulators.

Expected Outputs:

- Fair pricing mechanisms and contract farming models developed.
- Local processing infrastructure for 10-DAB extraction supported.
- Policy incentives and trade facilitation frameworks implemented.

Actions:

- Conduct market studies and value chain analysis.
- Support public-private partnerships for establishing processing units.
- Facilitate price negotiation platforms for CFUGs and farmers.
- Advocate policy reforms and develop support mechanism to promote local production of final taxol products at the National level.

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Annex

Annex 1. List of person consulted

Makawanpur and Dhading District

1. Sabitri Subedi, Chulipran CF
2. Damodar Subedi
3. Bhima Kumari Bhujel, Ranger, Chitlang Division Forest Office, Bajrabarhi
4. Sagar Acharya
5. Maan Bahadur Pakhrin
6. Surya Bahadur Gole, NTFP Trader
7. Raju Shrestha, Technical Engineer, Evans
8. Bhim Raj Rumba
9. Chandra Bahadur Pakhrin
10. Balram Pakhrin
11. Kajiman Rumba
12. Sajan Gole, Ghalepakha CF
13. Jeet Bahadur Aale, Himchuli CF

Sindhuli, Fikkal Rural Municipality

1. Jhaindra Bahadur Budhathoki
2. Bel Bahadur Budhathoki
3. Ganesh Budhathoki
4. Mahendra Sunuwar
5. Padam Bahadur Karki
6. Bel Bahadur Budhathoki
7. Hari Budha Chhetri
8. Indra Prasad Bhattarai
9. Lalit Bhattarai
10. Ratna Maya Tamang

Lalitpur, Mahankal Rural Municipality

1. Madhav
2. Som Gole
3. Singbir Syangtang

4. Aadi Maya Thokar
5. Menuka Thokar
6. Ram Bahadur Pradhan
7. Dukman Singtang
8. Indraman Waiba
9. Beni Bahadur Timilsina
10. Ol Prashad Timilsina
11. Udhav Prashad Timilsina
12. Tuk Prashad Ghimire
13. Niraj Sapkota
14. Govinda Kumar Ghimire
15. Rajan Chaulagai
16. Ishwor Gautam
17. Sukram Waiba
18. Mith Ram Dahal
19. Jayaram Dahal
20. Bedhnath Dahal

Kathmandu, Chandragiri Municipality, Masine CFUG 1

1. Anil Tamang
2. Jaya Tamang
3. Kiran Tamang