NON-DETRIMENTAL FINDINGS OF NARDOSTACHYS JATAMANSI (D. DON) DC

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Photographs: Sangay Wangchuk

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This revised Non-detriment Findings (NDF) report is based on the nationwide survey on *Nardostachys jatamansi* conducted in 2020, with technical support from officials of Forest Divisions and Protected Areas under the Department of Forests and Park Services (DoFPS), Ministry of Energy and Natural Resources, Royal Government of Bhutan.

We deeply thank the authors and individuals involved in formulating the first NDF. Likewise, thanks are extended to the Nature Conservation Division and erstwhile Social Forestry and Extension Division for their invaluable input in the first NDF.

We gratefully acknowledge the Forest Monitoring & Information Division, DoFPS, for sharing the country's legal and illegal trade data of *N. jatamansi*. Similarly, we would like to thank Terra Himalaya for collaborating to conduct oil distillation, which enabled the team to derive the oil conversion factor. The Asian Forest Cooperation Organization is thanked for its funding support for the publication of this invaluable document.
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EXECUTIVE SUMMARY

Nardostachys jatamansi, locally known as "Pang-Poe," is a perennial herb endemic to regions of India, Nepal, Bhutan, and southwest China with significant ethnobotanical and commercial value. It grows in the alpine region and is increasingly harvested for trade, threatening the wild population and its survival. The rise in demand from industries relying on non-wood forest products (NWFPs), highlights a pressing need for effective management strategies to ensure sustainable harvesting.

Timely, the Royal Government of Bhutan has responded with a formulation of regulatory measures, including a management and marketing plan and national export quota fixation complementing Non-detriment Findings (NDF) to protect the species while allowing commercial use. To further complement these efforts, the Ugyen Wangchuck Institute for Forestry Research and Training (UWIFoRT) has reviewed and revised the former NDF of the species based on a nationwide population survey. This revised NDF sets a national export quota that balances ecological conservation with socio-economic benefits for local communities, allowing for sustainable trade that contributes to livelihoods without compromising the species' population. Moreover, domestication and artificial propagation trails, spearheaded by UWIFoRT, aim to alleviate pressure on wild populations and further enhance conservation efforts. Together, these measures represent a comprehensive approach to ensuring the long-term viability of *N. jatamansi* and the prosperity of local livelihoods.

Nardostachys jatamansi is a perennial rhizomatous herb (10 – 60) cm tall with a slender stem and a distinctive elongated rootstock with a stout, woody root. The plant's rhizomes are dark brown and have thick matted beards. *N. jatamansi* grows in open, moist slopes, alpine meadows, and rocky outcrops, at elevations ranging from 3,810 to 5,155 masl. The species shows higher population growth rates in meadow habitats than in rocky terrains, suggesting it to be a favourable habitat. Moreover, understanding the biological characteristics and ecological relationships is crucial for developing conservation strategies and sustainable management practices for this valuable species. In Bhutan, it is found on slopes of 25 to 45 degrees on a northern aspect, while studies elsewhere show its density increases with altitude, especially on west-facing slopes. It reproduces through autogamy, with fruit set rates varying from 40% for passive autogamy to 87% for geitonogamy. Adult flowering plants and seedling recruitment are more prevalent in meadows than in rocky habitats, and the species reaches reproductive maturity in 3 to 4 years, with a generation length of 3 to 10 years. However, natural subpopulations are experiencing rapid decline due to the combined effects of anthropogenic pressures and climate change.

Nardostachys jatamansi is widely used for ethnobotanical, medicinal and aromatic purposes. A significant portion of the plant is exported, indicating its economic value. In Bhutan, harvest is regulated by the Forest and Nature Conservation Act of 2023, while local communities are empowered with traditional rights to manage resources sustainably.

The Department of Forests and Park Services (DoFPS) serves as the Management and Scientific Authority under CITES, requiring permits for the commercial collection and export of *N. jatamansi* and formulated the first NDF in 2022. A nationwide species survey was conducted across 1,377 sample plots to assess its population, density, and stock. Subsequently, a revalidation survey involving 60 plots enumerated the number of rhizomes per plant and rhizome weight to derive conversion factors for transforming wet rhizomes into dried form and further to essential oil. An average of 5.87 kg of wet rhizomes is required to produce one kilogram of dried rhizomes. Likewise, the average oil conversion was determined to be 0.026521 per kg of dried rhizomes.

The estimates of AHL in wet weight, dried rhizomes, and essential oil utilize the conversion factors derived from the population survey, revalidation survey, and distillation data. An average fresh clump weight of 27.9 g is multiplied by the population (*N = 73603769.68*) to estimate 2054 mt of growing stock, while a conversion factor of 5.87 kg fresh rhizome was used to calculate 1 kg dried rhizome weight. Correspondingly, a conversion factor of 0.026521 of essential oil required per kg of dried rhizome is based on collaborative *N. jatamansi* distillation data. Therefore, this NDF prescribes an annual harvest of 82 mt in wet weight, 14 mt in dried form, and 371 kg of essential oil.

The NDF formulation follows the guidelines established by CITES, incorporating population assessment and sustainable harvest practices. In Bhutan, prior regulations under the Forest and Nature Conservation Act (FNCA) of 1995 lacked clarity on trade. This prompted the first formulation of an NDF for *N. jatamansi* by the National Conservation Division, DoFPS in 2022. The recent enactment of the FNCA (2023) provided roles for authorities and reinforced the necessity for NDFs for CITES Appendix II species, ensuring that trade does not threaten wild populations.

This comprehensive NDF will guide the sustainable usage and trade of *N. jatamansi*, safeguarding both its ecological integrity and economic value for Bhutan's communities. This NDF concludes that sustainable trade of *N. jatamansi* is feasible with adherence to the established harvest limits and continued monitoring. Ongoing conservation efforts coupled with research and community engagement are essential to preserving the species.

FOREWARD

DIRECTOR

Bhutan's rich biodiversity and profound cultural heritage are inextricably linked, forming the cornerstone of its national identity and sustainable development ethos. Among the medicinal plants of our alpine ecosystems, *Nardostachys jatamansi* locally known as "Pang-Poe" stands as a symbol of this delicate interdependence. This critically endangered medicinal plant, endemic to the Himalayas, embodies both ecological significance and centuries-old ethnobotanical traditions. Its rhizomes, integral to traditional medicine, incense, and spiritual practices, have sustained communities while anchoring fragile alpine habitats. Yet, increased demand and unsustainable exploitation threaten its survival, underscoring the urgent need for science-driven stewardship.

The Royal Government of Bhutan has long championed a conservation paradigm that harmonizes ecological integrity with socio-economic resilience. The enactment of the Forest and Nature Conservation Act (2023) and Bhutan's commitment to international frameworks like CITES reflect this resolve. As a CITES Appendix II-listed species, *Nardostachys jatamansi* demands meticulous governance to ensure its trade does not endanger wild populations. This Non-Detriment Findings (NDF) report, a collaborative endeavour led by the UWIFoRT, represents a milestone in translating policy into actionable conservation strategy.

Groundbreaking nationwide surveys, revalidation studies, and interdisciplinary research underpin this revised NDF. By quantifying population dynamics, habitat preferences, and sustainable harvest thresholds, the report establishes a science-based framework to balance economic opportunity with species viability. The prescribed annual harvest limits of 82 metric tons of fresh rhizomes, 14 metric tons dried, and 371 kilograms of essential oil realize Bhutan's precaution, ensuring extraction does not threaten the species' survival. Crucially, the integration of *ex-situ* propagation and community-led management models indicates a transformative shift toward long-term resilience.

This document is a testament to Bhutan's pioneering spirit in conservation. It underscores the indispensable role of collaboration among researchers, policymakers, local communities, and international partners. By embedding traditional knowledge within modern scientific diligence, the report not only safeguards *Nardostachys jatamansi* but also reinforces the socio-economic fabric of rural Bhutan.

As we steer the challenges of biodiversity loss and climate change, this NDF serves as both a blueprint and a call to action. It invites stakeholders to uphold sustainable practices, innovate conservation technologies, and foster inclusive governance. The DoFPS extends its deepest gratitude to all contributors whose dedication has illuminated this path forward. Together, let us ensure that future generations inherit a world where nature and culture persist to thrive in harmony.

TASHI DELEK!

Karma Tenzin

LIST OF ACRONYMS

AHL	Annual Harvest Limit
AITR	Annual Illegal Trade Report
AOO	Area of Occupancy
CCA	Canonical Correspondence Analysis
CCA	Canonical Correspondence Analysis
CITES	Convention on International Trade of Endangered Species of Fauna & Flora
COP	Convention of Parties
DoFPS	Department of Forests and Park Services
EOO	Extent of Occurrence
FMID	Forest Monitoring and Information Division
FIRMS	Forestry Information Reporting & Monitoring System
FNCA	Forest & Nature Conservation Act of Bhutan 2023
FNCRR	Forest & Nature Conservation Rules and Regulations 2023
FRPMD	Forest Resources Planning & Management Division
IUCN	International Union for Conservation of Nature
JDNP	Jigme Dorji National Park
JKSNR	Jigme Khesar Strict Nature Reserve
KIL/kg	Kilogram
MoENR	Ministry of Energy and Natural Resources
mt	Metric Tons
NCD	Nature Conservation Division
NDF	Non-Detriment Finding
NWFPs	Non-Wood Forest Products
POWO	Plants of the World
RD	Relative Density
ROO	Root
SA	Scientific Authority
SWS	Sakteng Wildlife Sanctuary
TAC	Technical Advisory Committee
UWIFoRT	Ugyen Wangchuck Institute for Forestry Research and Training
WCNP	Wangchuck Centennial National Park

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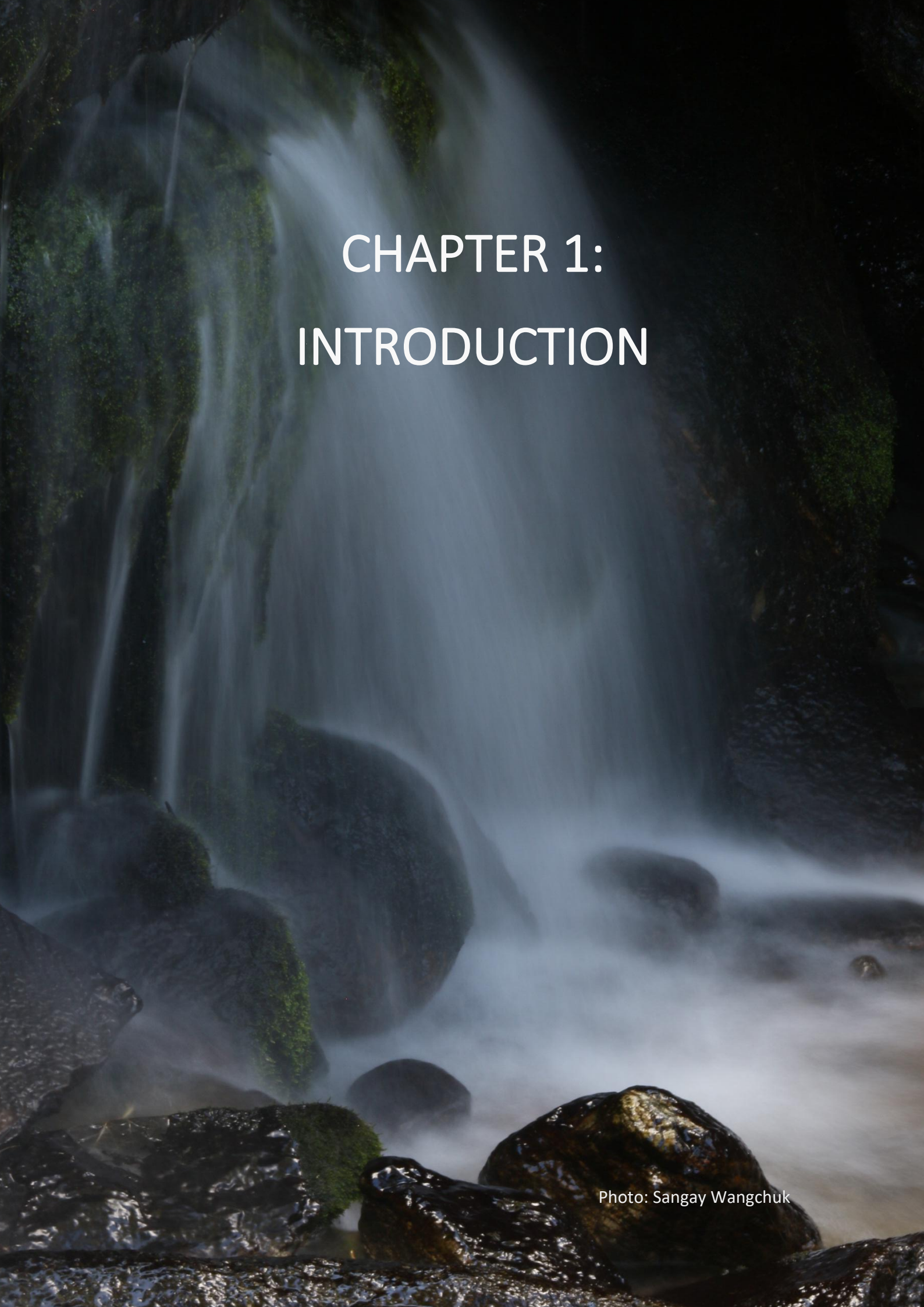

Photo: Sangay Wangchuk

BACKGROUND

Nardostachys jatamansi, locally known as “Pang-Poe”, is a perennial rhizomatous herb belonging to the Caprifoliaceae family. It is also referred to by its heterotypic synonym *Nardostachys grandiflora* (POWO, 2024). This species is endemic to the Himalayas and found in India, Nepal, Bhutan, and southwest China. In Bhutan, it grows at altitudes ranging from 3,810 to 5,155 meters above sea level (masl), in the districts of Thimphu, Haa, Paro, Gasa, and Bumthang (Grierson & Long, 2001).

N. jatamansi has diverse uses, ranging from ethnobotanical applications to commercial use. However, recent trends show increased harvesting for international trade, often conducted without sustainable management practices. This uncontrolled collection poses a significant threat to the species' survival in the wild, especially as small-scale industries and enterprises relying on NWFPs continue to grow. The perceived easy access to natural resources for profit risks their long-term sustainability. To address this, harvesting is regulated through permits based on annual limits, and a management and marketing plan has been established to allow for the sustainable commercial use of 108 species, including *N. jatamansi*. (Wangchuk et al., 2011; Dema, 2017; DoFPS, 2022).

Ensuring trade within sustainable limits is central to CITES. Therefore, the Scientific Authority (SA) of the State of Export has to advise that “such export will not be detrimental to the survival of that species and ensure sustainable trade practices" (Article IV).

In this context, the Ugyen Wangchuck Institute for Forestry Research and Training (UWIFoRT) reviewed and revised the previous NDF based on the baseline data from nationwide surveys conducted in 2020. The NDF aims to estimate growing stock and set a national export quota to maintain sustainability while providing socio-economic benefits for Bhutanese communities. Implementing a national export quota ensures that trade levels do not adversely impact the species' population, aligning with CITES requirements (Resolution Conf. 14.7. CoP 15, 2019). This approach will enhance economic benefits and improve community livelihoods without compromising conservation policies and national legislation. Recently, the Terra Himalaya in collaboration with UWIFoRT, initiated artificial propagation to reduce pressure on the wild populations.

This NDF for *N. jatamansi* in Bhutan is a revision of the first NDF formulated by Gyeltshen et al. (2022). The report provides critical insights on quantification for harvest and sustainability of *N. jatamansi* to ensure its long-term survival and economic benefits for Bhutan.

BIOLOGICAL CHARACTERISTICS

The perennial rhizomatous herb is between 10 and 60 cm in height with a slender stem. The plant consists of an elongated rootstock with a stout, woody root. The rhizomes resemble a thick beard, characterized by their dark brown hue and the remnants of old leaf bases, which gives rise to its common name, *'Jatamansi'*. The etymology of the common name is derived from a combination of two Sanskrit words: *'jata'*, which refers to matted and entwined hair, and *'mansi'*, referring to mental or spiritual devotion (Chauhan et al., 2023).

The leaves are either radical or cauline, growing oppositely and exhibiting a linear-oblanceolate shape, measuring 5–20 × 1.5–4 cm. The leaves have entire margins, an obtuse apex and it taper into a petiole. The cauline leaves are typically 1 or 2 paired, measuring 2.5–6 × 0.5–9 cm, and are sessile, lanceolate, or linear-oblong with coarse dentation. The plant upon reaching maturity in the third year and beyond begins to produce flowering shoots that form 3–7 cyme heads at the top (Chauhan et al., 2008). The inflorescence may feature one or 2 to 3 terminal capitate clusters. The flowers are generally pale pink or blue, hermaphroditic, gamosepalous with well-defined segments, actinomorphic, capitate, and bell-shaped. The fruits are achenes, containing one seed, and are obovoid, elongated, and flattened, averaging 6.7 ± 0.8 fruits per flowering ramet (n = 49) (Chauhan et al., 2023).

HABITAT AND ECOLOGY

N. jatamansi primarily occurs in open, moist slopes on rocky outcrops, alpine meadows, and *Juniper* and *Rhododendron* scrubs. The recorded elevations range from 3464 masl to 4766 masl during the survey period (Gyeltshen et al., 2022). Population growth rates are higher in meadow habitats compared to rocky habitats (Chauhan et al., 2023; Ghimire et al., 2008; Dema, 2017). Dominant species associated with *N. jatamansi* include *Bistorta macrophylla* (D.Don) Soják, *Cassiope fastigata* (Wall.) D.Don, *Cotoneaster microphyllus* Wall. ex Lindl., *Gentiana urnula* Harry Sm., *Morina nepalensis* D.Don, *Rhododendron anthopogon* D.Don, *Rhododendron setosum* D. Don, and *Saxifraga moorcroftiana* (Ser.) Wall. ex Sternb. (Dema, 2017). Gyeltshen et al. (2022) reported dominant plant families associated with *N. jatamansi* as Compositae (n=78 species), Rosaceae (n=38), Ranunculaceae (n=29), Primulaceae (n=27), Scrophulariaceae (n=26), and Gentianaceae (n=23).

In Bhutan, the presence of *N. jatamansi* in Bhutan is attributed to slopes ranging from 25 to 45 degrees and northern aspects (Gyeltshen et al., 2022). However, Chauhan (2021) reported that plant density and frequency are positively correlated with altitude, with higher density observed on west-facing slopes. The species primarily reproduces through autogamy, although geitonogamy may also occur. Chauhan et al. (2008) reported fruit set percentages of 40% for passive autogamy, 70% for active autogamy, 53% for xenogamy, and 87% for geitonogamy. The frequency of adult flowering plants is higher in meadow populations than in rocky habitats (Ghimire et al., 2008). Seedling recruitment rates are also higher in meadows compared to rocky outcrops. Additionally, the species reproduces both vegetatively and by seeds, with plants taking 3 to 4 years to reach reproductive maturity. The generation length of the species ranges from 3 to 10 years (Larsen & Olsen, 2008).

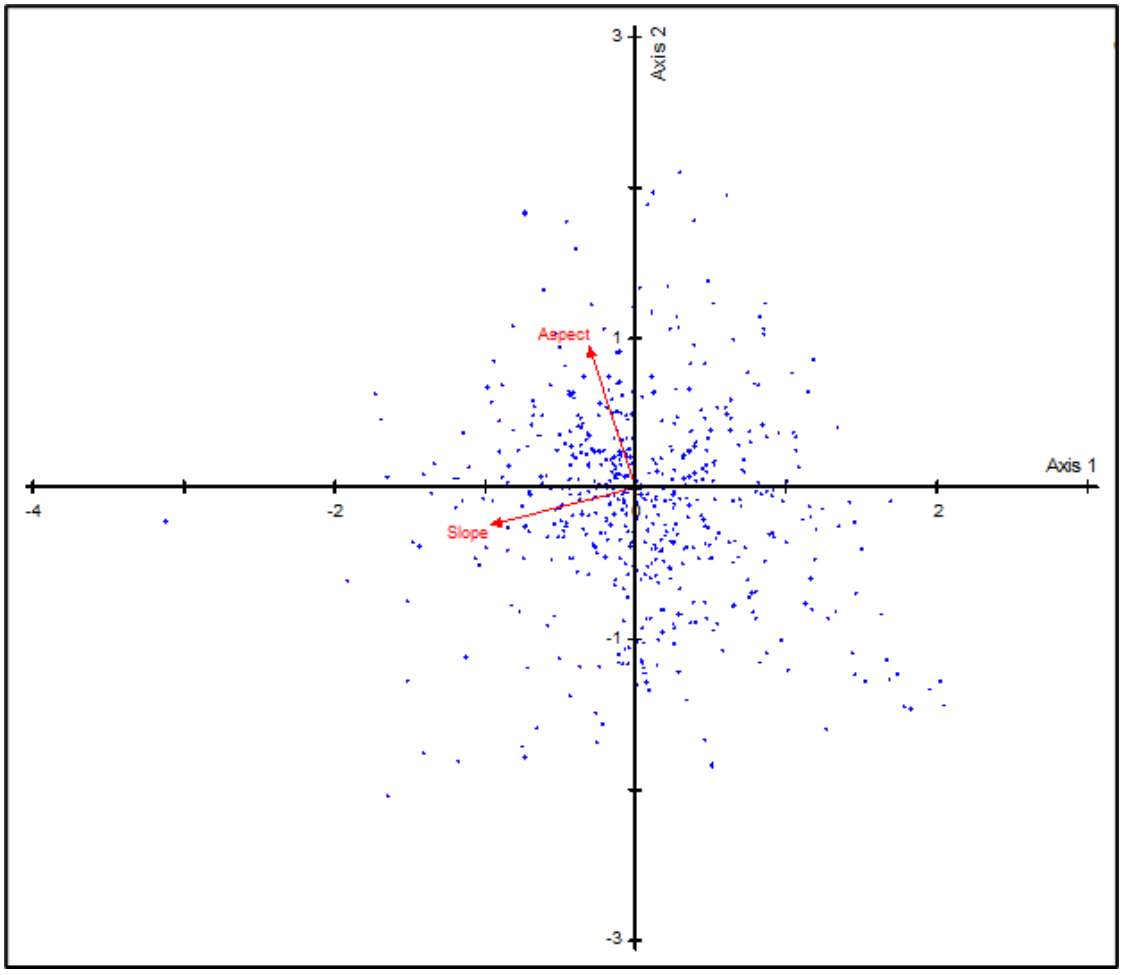

Figure 1. CCA biplot showing the relationship between species and environmental factors: species significantly related to slope and aspect are associated with these variables in the environmental space (Gyeltshen et al., 2022)

FLORISTIC COMPOSITION AND DISTRIBUTIONS.

The analysis of the former NDFs of *N. jatamansi* revealed the floristic composition and major life form distribution in Bhutan. A total of 537 plant species within 40 families were recorded, including 65 trees and shrubs, 427 herbs, 31 graminoids (grasses), and 14 spore-bearing plants such as ferns, fungi, moss, and lichen. The Relative Density % (RD) of different life-form groups were as follows: 41% for herbaceous plants, 36% for woody species, 17% for *N. jatamansi*, 6% for graminoids, and 1% for spore-bearing plants. The highest RD % for *N. jatamansi* was found in BWS at 28.69%. Bumthang Division, JKSNR, and JDNP had a similar RD of 20%. Likewise, the RD in SWS, Paro Division, PNP, and WCNP ranged from 12.73% to 16.5%, while Thimphu had the lowest at 2.76%. Out of the 1377 survey plots, 242 plots had no presence of *N. jatamansi* within their Area of Occupancy (AOO).

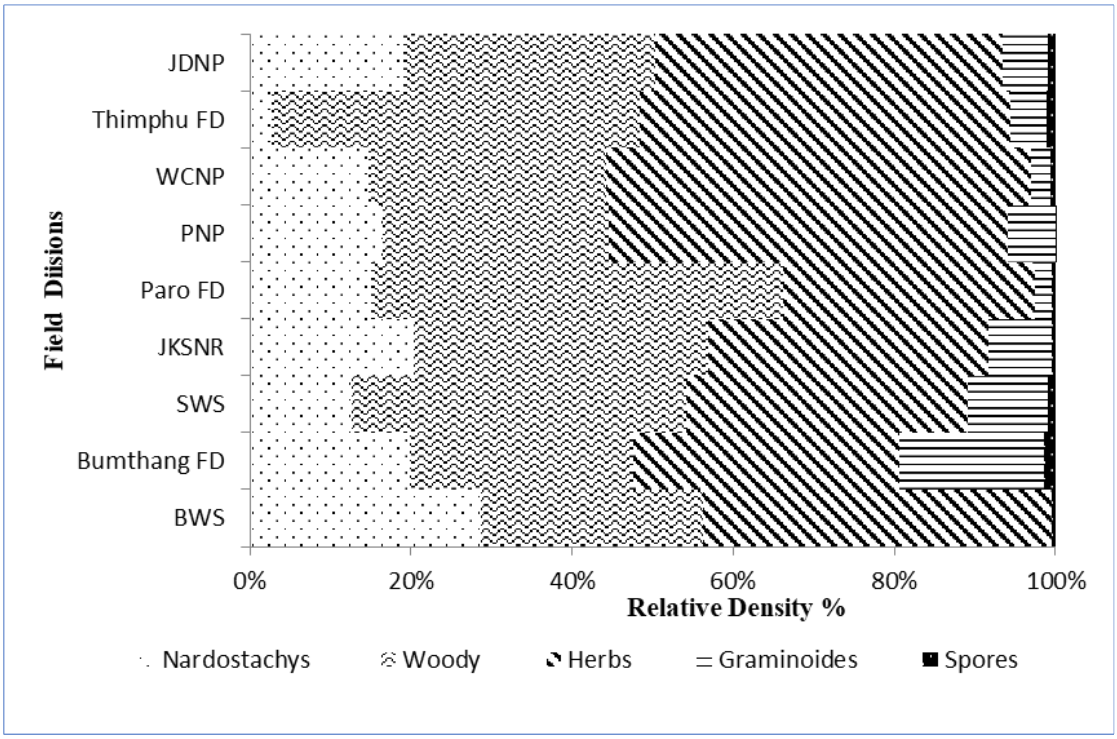

Figure 2. 100% stacked graph showing division-wise distribution pattern and proportion of five lifeform groups of herbaceous plants including *N. jatamansi* species, woody perennials, graminoids composed of grass, hedge and sedge and very less cover % of spore-bearing plants.

ROLE OF THE SPECIES IN ITS ECOSYSTEM

N. jatamansi is a small plant growing in clusters or patches, which can appear dense in areas where it occurs. Although it is generally not very common in any of the habitats, no studies have been conducted in Bhutan (Larsen & Olsen, 2008).

CURRENT GLOBAL POPULATION AND CONSERVATION STATUS

The overall population of *N. jatamansi* across its entire distribution is poorly documented. Average plant density varying from 0.21 to 32.2 individuals/m^2 in the range countries are reported with density of 19.0 to 32.2 individuals/m^2 in Garhwal, 0.83 individuals/m^2 in Valley of Flowers National Park, 0.94 individuals/m^2 in Kedarnath Wildlife Sanctuary, 0.21- 0.41 individuals/m^2 in Nandi Devi Biosphere Reserve and 8.9 individuals/m^2 in Lingzhi Dungkhag were documented (Airi et al., 2000; Nautiyal et al., 2003; Kala 2005; Negi et al., 2018; Lakey & Dorji, 2016). The trend in density appears unclear due to the fragmented data.

Natural subpopulations of the species are experiencing rapid and alarming declines (Dhiman & Bhattacharya, 2020). The decrease in the wild populations is further exacerbated by anthropogenic pressures such as habitat fragmentation, illegal trade, overexploitation, overgrazing, and unsustainable development activities (Larsen & Olsen, 2008). These threats have negatively impacted the long-term sustainability of the species through habitat loss, degradation, and overharvesting. As a result, the species is listed as Critically Endangered under criteria A2cd of the IUCN Red List (Chauhan, 2021).

USE OF THE SPECIES

The roots of *N. jatamansi*, leaves, and stems of *Rhododendron ciliatum* Hook.f., *Rhododendron setosum* D.Don and *Tanacetum nubigenum* Wall ex DC. aerial parts are widely used in Asia for medicinal and aromatic purposes (Larsen & Olsen, 2008). *N. jatamansi* is also used as a detoxifier and treatment for chronic fever and heart disorders (Wangchuk & Olsen, 2008). In addition, it is used as an important ingredient in the production of incense, essential oils, and perfumes. More than half of the national collections are exported to India and the rest are supplied to the domestic market for traditional medicine, incense, perfumes, etc. The essential oil content of rhizomes known as spikenard oil is reported to be effective in treating leprous wounds (Gautam & Raina, 2016; Wangchuk et al., 2008). In Bhutan, pounded plants are mixed with other plant material (locally known as “sang”) and used primarily to manufacture incense, which is burned during religious rituals and ceremonies to appease local deities and gods (Mulliken & Crofton, 2008). Due to its medicinal properties, the species continues to be extensively exploited resulting in over-harvesting and habitat loss.

HARVEST REGIME AND MANAGEMENT

Nardostachys jatamansi is harvested from state-reserved forests, and its sustainability is governed by the Forest and Nature Conservation Act of Bhutan and the Forest and Nature Conservation Rules and Regulations (DoFPS, 2023). Local communities are empowered to manage resources within the area where they hold traditional and customary rights, with approved resource management and marketing plans (FNCRR, 2023). The implementation of group activity is periodically monitored by the DoFPS. To ensure the sustainability of resources, the group must obtain a collection permit from the forest office before the commencement of resource collection. Permits are issued based on the annual harvesting limits specified in the management and marketing plan. Additionally, the group must adhere to the harvesting prescription outlined in the plan as per the NDF prescription to ensure that their collection methods do not threaten the species.

LEGAL AND ILLEGAL TRADE LEVELS

The level of international trade detected by enforcement agencies was based on the CITES Annual Illegal Trade Report submitted to the Repository Government Geneva, Switzerland for 2 years as shown below.

Table 1. CITES Annual Illegal Trade Report of Bhutan, 2019 - 2020

Date of seizure	Species	Description of specimen	Quantity	Unit
25/11/2019	*Nardostachys jatamansi*	ROO	70	KIL
27/11/2019	*Nardostachys jatamansi*	ROO	270	KIL
30/12/2019	*Nardostachys jatamansi*	ROO	331.15	KIL
09/07/2020	*Nardostachys jatamansi*	ROO	15.00	KIL

The economic value may pose a threat leading to overexploitation of forest resources (Thakuri, 2018). However, much of the decline in other Trans-Himalayan regions is attributed to the loss of natural habitat. Precise and recorded figures on informal and illegal collection and trade of medicinal plants are not available.

LEGAL FRAMEWORK AND LAW ENFORCEMENT

The Ministry of Foreign Affairs of the Royal Government of Bhutan formally accepted the amendment to Article XXI of the CITES Convention on 15 August 2002. Consequently, authorities were designated from within the Department of Forests and Park Services based on relevancy until the legal designation of authorities accorded the Forest and Nature Conservation Act of Bhutan, 2023. The Director, DoFPS, and Ugyen Wangchuck Institute for Forestry Research and Training were respectively delegated as the country's Management Authority and Scientific Authority.

The collection of *N. jatamansi* or any other NWFPs requires a permit (Certificate of Origin) from the DoFPS for commercial use. Consequently, the export of specimens listed in the CITES Appendix II requires a CITES permit from the Management Authority. To address the issue of traceability, the CITES permit system is incorporated into the Online Forestry System, DoFPS. Along with the CITES permit, a Material Transfer Agreement following the Biodiversity Act of Bhutan, 2022, and a phytosanitary certificate from the Bhutan Food and Drug Authority are mandatory.

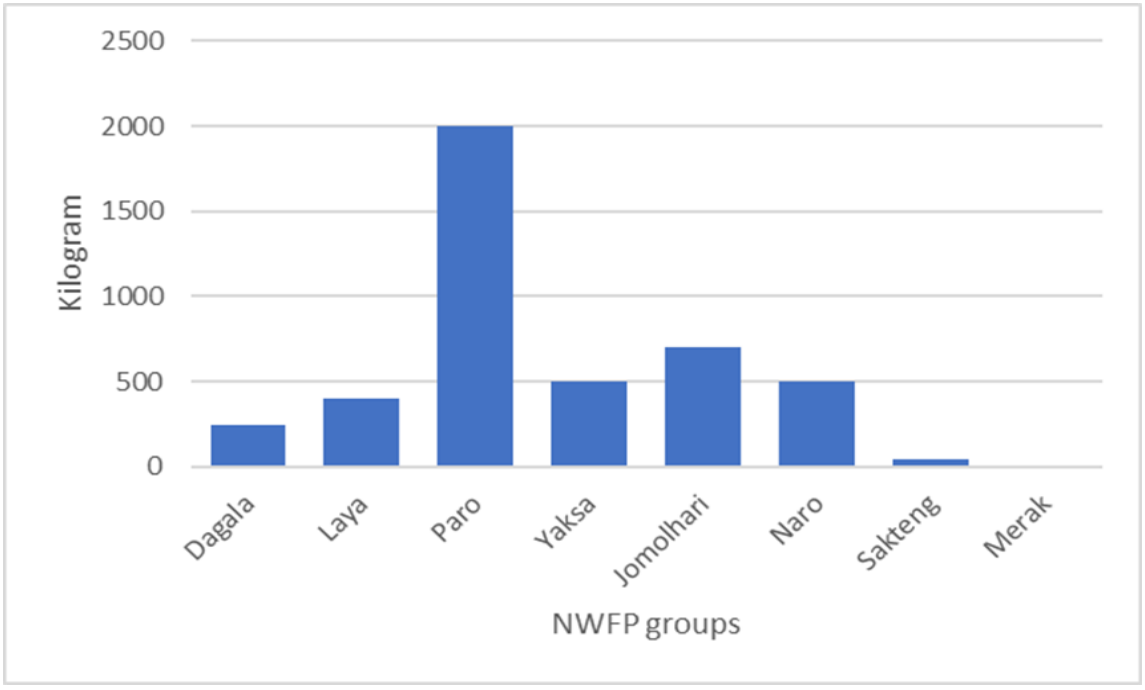

Figure 3. Current level of harvest by the existing NWFP user group in the country

CHAPTER 2:

NON-DETRIMENT FINDINGS PROCESSES AND RESULTS

Photo: Sangay Wangchuk

OVERVIEW OF PROCESS FOR DEVELOPMENT OF THE NDF.

In 1960, the 7th Union General Assembly of the IUCN emphasized the adoption of import restrictions attuned to the export regulations of the countries of origin (IUCN, 1960). In 1992, the COP approved Resolution Conf. 8.6, which addressed the role of the Scientific Authority. This resolution instructed the Secretariat to develop general guidelines for Scientific Authorities to conduct necessary scientific reviews as outlined in Articles III, IV, and V of the Convention, and to submit these guidelines for review by the Animals Committee and Plants Committee (CITES, 2024). The NDF methodology was first published by the IUCN (Rosser & Haywood, 2002). Subsequent refinement during the Cancun NDF workshop in 2008, led to the development of NDF guidance (Rose, 2014). Leaman & Oldfield (2014) proposed a nine-step methodology for NDF studies, further tailored for perennial plants by Wolf et al. (2016).

Previously, the collection and sustainable management of NWFPs including *N. jatamansi* was regulated by the (FNCA, 1995) and its subsequent rules and regulations. However, these regulations lacked clarity regarding international trade. As a party to the CITES, Bhutan formulated the first NDFs of *N. jatamansi* in 2022 by NCD, DoFPS to regulate trade and set export quotas.

The recent enactment of (FNCA, 2023), clarifies the roles of Authorities and details the requirement of NDF for species listed in CITES appendix II. This ensures that the trade of the species does not threaten the species' survival in the wild. Hence, the first NDF for this species has been meticulously reviewed and Non-detrimental Findings are presented herein. This NDF follows the 9-step CITES Non-detriment Findings Guidance for Perennial Plants, as Wolf et al. (2016) outlined.

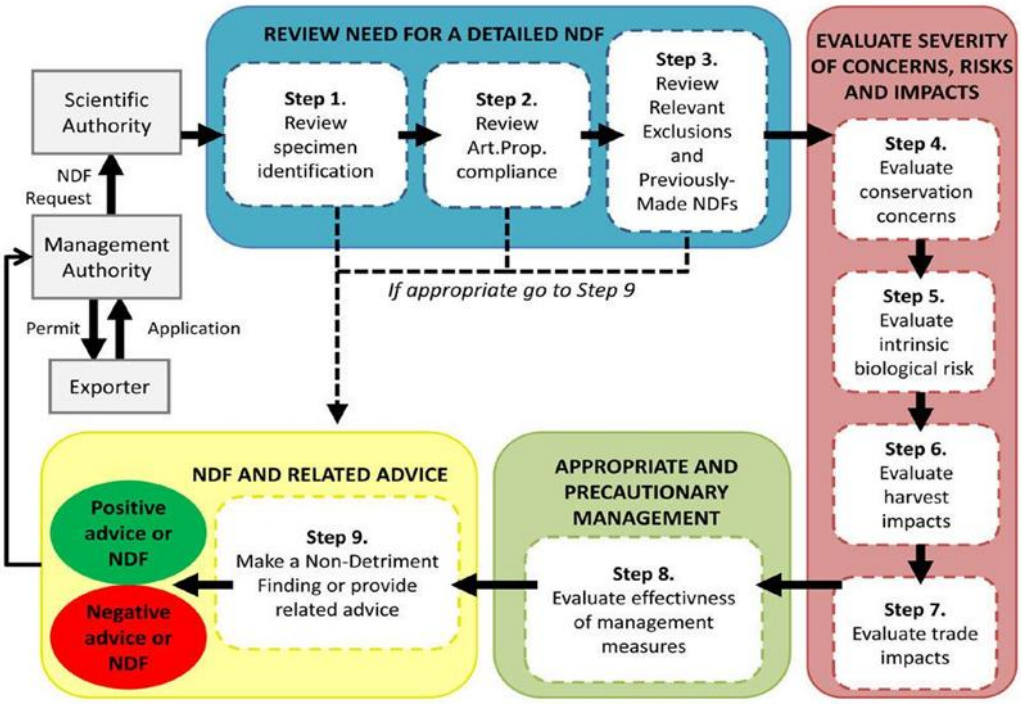

Figure 4. Nine-step pathways for making NDF for perennial herbs of CITES Appendix II (Wolf et al. 2016).

EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT.

The nationwide survey of *N. jatamansi* was carried out in 1,377 sample plots laid in potential growing areas of Bhutan. JDNP had the highest number of plots, with 504 plots followed by JKSNR with 213 plots, while BWS had the lowest with 32 plots. The collected data was employed to estimate the population, plant density, growing stock, harvesting limits and quota fixation of the species using predefined mathematical formulas. Further, the current level of *N. jatamansi* harvested in the country was verified through permits issued by the DoFPS, and data on the illegal trade of the specimen were verified from the past CITES Annual Illegal Trade Report submitted to the repository government. The review of population distribution, density, quantification and values of conversion factors were adopted from the revalidation survey conducted in two major *N. jatamansi* producing NWFPG and relevant literature (Lakey & Dorji, 2016; Wangchuk & Olsen, 2008). The threats analysis was adopted from the previous NDF.

METHODOLOGY.

This report used counts of individual plants, and area of occupancy to ascertain plant density per plot and the overall population throughout the country. Additionally, a revalidation survey was conducted in two primary *N. jatamansi* -producing NWFP groups in Dotey and Naro, involving the enumeration of 59 sample plots, each measuring 2 x 2 meters. The field data included plant height, percentage of plant cover, the number of rhizomes per plant, the total weight of the rhizomes, and other relevant site information. A clump of rhizomes was collected from each sample plot during the revalidation survey to determine the average weight of the *N. jatamansi* clump. These values were essential for establishing conversion factors to transform wet rhizomes into dried form and dried rhizomes into essential oil. This report utilizes collaborative distillation data for *N. jatamansi* oil from Terra Himalaya to determine and verify the conversion values from dried rhizome to oil. Data from four separate oil distillation instances were analyzed to derive the average oil conversion value.

Figure 5. Graphical example of the relationship between Extent of Occurrence, Range, Area of Habitat, and Area of Occupancy (CITES).

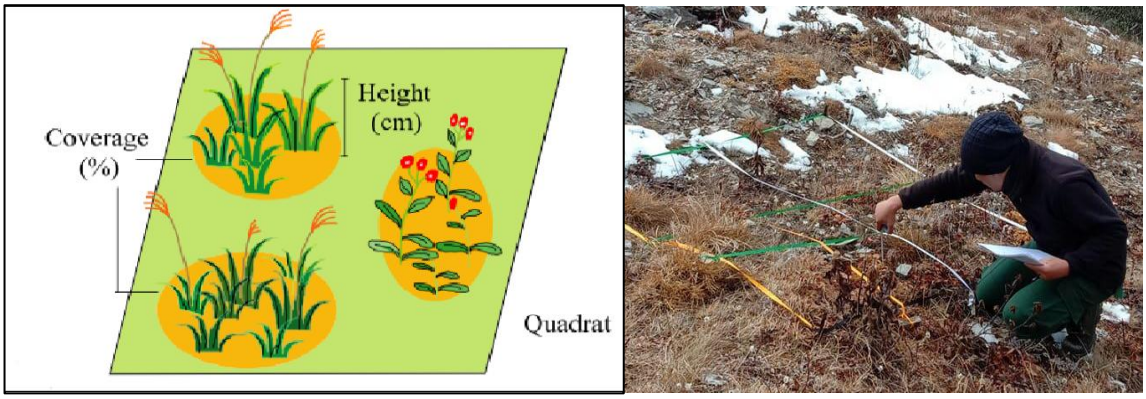

Figure 6. Quadrate plot design and the cover % of each species inside the plot.

BASIS OF ESTIMATION

The estimates of AHL in wet weight, dried rhizomes, and essential oil are based on the conversion factors derived from the analysis of currently available data. An average wet weight value of **27.9 g** per clump of *N. jatamansi* was determined from the revalidation survey to estimate the growing stock in wet weight. A total of 1,628 g of fresh rhizomes collected during the revalidation survey yielded 277.13 g of rhizomes dried at room temperature for one month. Based on the conversion, a conversion factor of **5.87 kg** (wet rhizome) is determined to convert into a kilogram of dry rhizome. Published literature reports the presence of variations in plant density, weight, and yield. Oil yields ranging from 0.57 to 2.9% of the dry weight of rhizomes are reported from Nepal (Amatya, 2005). Likewise, Chauhan (2011) stated a variation of essential oil content values between 0.83% to 1.22% on a dry weight basis. Olsen (2005) suggested an average oil content of 1.5%. However, in our context, an essential oil yield of **2.26%** was achieved with conversion factors of **0.026521 kg** per kilogram of dried rhizome based on the four instances of distillation carried out collaboratively with Terra Himalaya for the rhizomes collected from NWFPG in Naro and Dotey. Since the oil content shows higher yield coupled with great variation in oil constituents, suspected to have been caused by the post-harvest technology applied, thermal damage during the drying period and microclimatic variation (Chauhan et al., 2017), 2.62% will be considered the highest value. Similarly, the Toucher method indicated that these variations among individuals are attributed to environmental and genetic effects (Rao, 1952).

Figure No. 7. Distillation stages and variation of essential oil of *N. Jatamansi*: Brownish in the first hour & greenish in the later stages.

Table 2. Annual Harvesting Limit for respective parks and divisions.

No	Place	AOO (m^2)	Density	Population	Growing stock (mt)	AHL (mt)
1	Thimphu	87681	14	1195444	33	1.3
2	JKSNR	635395	39	25092715	700	28.0
3	PNP	17716	15	273913	8	0.3
4	WCNP	213699	25	5303571	148	5.9
5	SWS	60996	10	592500	17	0.7
6	Paro FD	60236	21	1277641	36	1.4
7	BWS	3996	29	114643	3	0.1
8	Bumthang	44575	25	1104000	31	1.2
9	JDNP	1756788	22	38649343	1078	43.1

QUANTIFICATION OF NARDOSTACHYS JATAMANSI.

The nationwide survey of *N. jatamansi* conducted in 2022 revealed 2.8 km^2 of land as a growing area in the country. However, Chetenla (2023) stated that 7,210 km^2 of alpine regions are suitable for *N. jatamansi*, representing 18.78% of the country's total area of which 421 km^2 is classified as highly suitable, 2,605 km^2 is moderately suitable and 4,184 km^2 as less suitable. A plant density of 8.9 plants/m^2 of *N. jatamansi* is reported from Lingshi Dungkhag, JDNP (Lakey & Dorji 2016). Dema (2017) also reported a mean plant density of 11.78 plants/m^2. However, the current NDFs analysis reveals an average plant density of **22.1 plants/m^2**, ranging from 14 plants/m^2 to 39 plants/m^2 across various parks and divisions.

Bhutan is estimated to harbour a population of approximately **73,603,770** *N. jatamansi* individuals. Based on the total population, **2,053 mt** of growing stock in a wet form, equivalent to **350 mt** in dried form is estimated. Furthermore, implementing a sustainable harvest strategy stipulates an annual harvest limit of **82 mt** in wet weight and **14 mt** in dried form equivalent to 4% of the population harvested annually with a 5-year rotation period. Despite the habitat type, the harvest limit is set at a cumulative of 20% in 5 years to ensure the sustainability of the species without exceeding the maximum limit (25%) recommended by Ghimire et al. (2008).

CHAPTER 3:

9-STEP NDF PROCESSES AND ADVICE

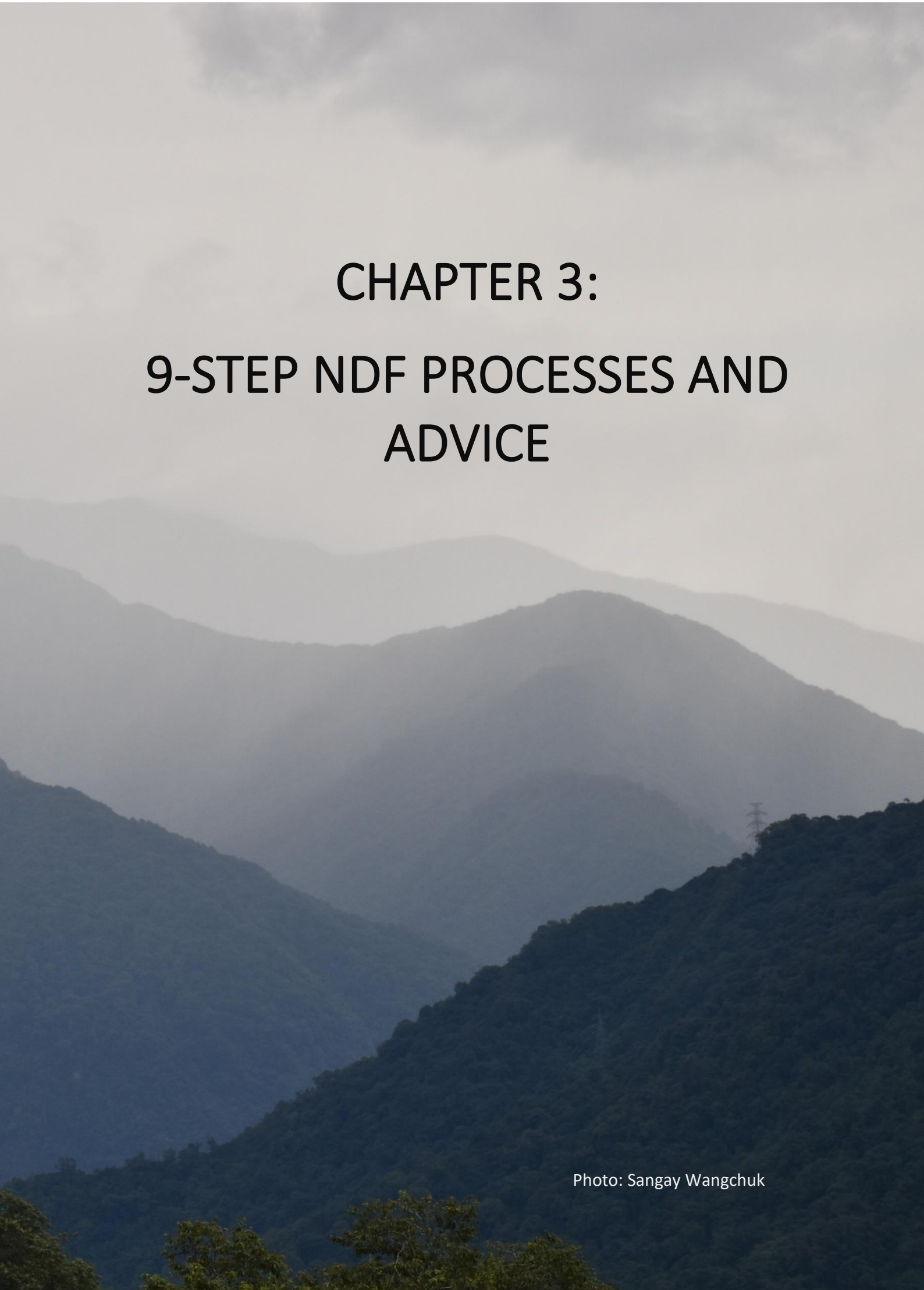

Photo: Sangay Wangchuk

STEP 1: REVIEW OF SPECIMEN IDENTIFICATION

Has the plant/specimen been correctly identified and is the scientific name used compliant with the appropriate CITES standard?

The specimens are correctly identified at the species level as *Nardostachys jatamansi*. There is no uncertainty related to the taxonomic classification and identification of this species, as it has been confirmed and validated through examination of wild specimens and relevant literature (Grierson & Long., 2001; Qiner et al., 2011). The taxonomic classification of the species follows the Plants of the World, International Plant Names Index, and IUCN Redlist of Threatened Species.

STEP 2. REVIEW ARTIFICIAL PROPAGATION COMPLIANCE

2.1. Is the permit application for artificially propagated specimens?

No. The permit application is for specimens collected from the wild (source code W).

STEP 3: REVIEW OF RELEVANT EXCLUSIONS AND PREVIOUSLY- MADE NDF's

3.1. Is the harvest or the export of wild-harvested specimens of this species permitted by national or relevant sub-national legislation or regulation?

Yes. The harvest or the commercial export of *N. jatamansi* is permissible by the Forest and Nature Conservation Act of Bhutan (DoFPS, 2023) and Forest and Nature Conservation Rules and Regulations (DoFPS, 2023).

3.2. Is the specimen covered by CITES Appendix II?

Yes. *Nardostachys jatamansi* is enlisted in the Appendix II of the CITES.

3.3. Has the Scientific Authority previously made a science-based NDF for this species that is still valid and sufficient to evaluate the specimens for the current export permit application?

The NDF for *N. jatamansi* has been previously formulated however it is hereby reviewed with the inclusion of conversion factors and calculation of growing stock based on population for the current export permit application.

STEP 4: REVIEW OF CONSERVATION CONCERNS

4.1. Has the conservation status of the species been assessed?

Yes, *N. jatamansi* is assessed Critically Endangered as per criteria A2cd of the IUCN Redlist based on decreasing population trends, continuing decline in mature population and numerous anthropogenic threats facing the species in the wild. It is likewise, enlisted in SCHEDULE II of the Forest and Nature Conservation Act of Bhutan ensuring high conservation priority.

4.2. Considering the existing conservation status assessments, what is the indicated severity of conservation concern?

Conservation concerns for *N. jatamansi* arise from its low regeneration rate in the wild, influenced by factors such as low seed viability, irregular seed production, unsuitable micro-sites, climate change, and illegal harvesting. The species faces habitat loss, overexploitation, human activities, and overgrazing (Dema, 2017). However, considering the stable population size and large area suitable for the growth of the species, the severity of the conservation status for this species in Bhutan is assessed as Medium.

Table 4. Threat ranked according to field observation and the consultation

Direct Threats	Scope	Severity	Irreversibility	Total	Overall Threat Rating
Grazing and trampling by livestock	2	1	1	7	Low
Illegal and rampant collection	3	4	3	17	Very High
Unsustainable and untimely collection	3	3	3	15	High
Use of lethal harvesting techniques	3	3	3	15	High
Intentional fire	1	1	1	5	Low
Landslide and soil erosion	1	1	1	5	Low
Waste disposal	2	2	1	9	Medium
Climate change	2	1	2	8	Medium

Scoring criteria			
Rank	Scope	Severity	Irreversibility
Very high	4	4	4
High	3	3	3
Medium	2	2	2
Low	1	1	1

Overall Threat Ranking	
Rank	Score range
Very high	16-20
High	11-15
Medium	6-10
Low	1-5

Note: Total = 2 * (Scope + severity)+Irreversibility

Definition

Scope: *The proportion of the target that can reasonably be expected to be affected by the threat within ten years, given the continuation of current circumstances and trends*

Severity: *Within the scope, the level of damage to the target from the threat that can reasonably be expected given the continuation of current circumstances and trends.*

Irreversibility: *the degree to which the effects of a threat can be reversed and the target affected by the threat restored.*

STEP 5: EVALUATION OF POTENTIAL BIOLOGICAL RISK OF HARVEST FROM WILD AND CULTIVATED POPULATION

5.1. What is the severity of intrinsic biological risk factors?

The intrinsic biological risk associated with harvesting the plant is high because it involves removing the entire rhizome, which reduces the chances of natural regeneration.

STEP 6: EVALUATE THE IMPACT OF WILD HARVEST

6.1. Considering the impacts of harvest, is the severity of harvest impact on individual plants, target populations, the national population, and on other species "Low", "Medium", "High", or "Unknown"?

The severity of harvest impact on individual plants is "*high"* and the severity on target populations and national population is "*medium*". The severity of harvest impact on other species is *"medium".*

STEP 7: WHAT IS THE IMPACT OF LEGAL AND ILLEGAL TRADE ON THE NATIONAL POPULATIONS OF THE SPECIES CONCERNED

7.1. Considering the impacts of trade of this export as well as considering the impact of all trade on species survival, is the severity of legal and illegal trade impact "Low", "Medium", "High", or "Unknown"?

The severity of the impact of legal trade is **"Low"** whereas the effects of illegal trade are **"High".** The reduced impact of legal trade can be attributed to sustainable harvesting practices and management measures, which mitigate potential intrinsic biological threats to the species. In contrast, the impact of illegal trade is considered high, as sustainable harvesting and management strategies have minimal effect.

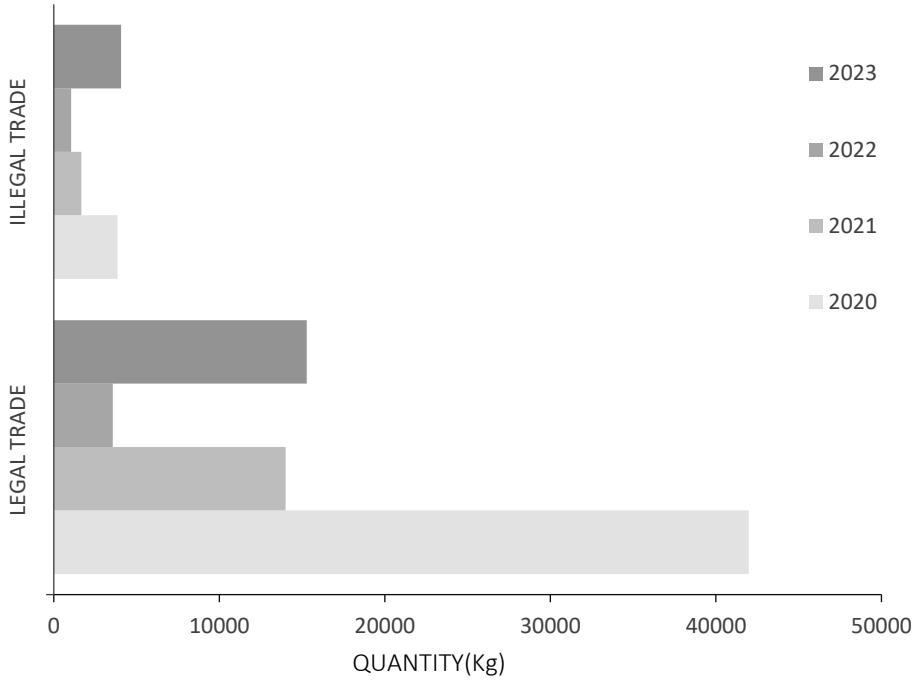

Figure 8. Graph showing the level of Legal and Illegal trade of *N. jatamansi* (2020-2023)

STEP 8. EVALUATE THE EFFECTIVENESS OF MANAGEMENT MEASURES.

8.1. Which management measures are in place for the target species?

Our legislation adequately mitigates or regulates the sustainable collection or harvesting of the target species. The Department has put effective conservation and management measures in place to regulate the sustainable collection of *N. jatamansi* based on the Forest and Nature Conservation Act and subsequent rules (DoFPS, 2023), National Strategy for Development of Non-wood Forest Products (SFD, 2008) and Forest and Nature Conservation Code of Best Management Practices of Bhutan (DoFPS, 2021).

The NWFPs are protected, conserved and managed sustainably under a cross-cutting Management regime which will be part of the area-based management regime. However, a separate NWFP Management plan is prepared for successful implementation of the plan which prescribes AHL for specific NWFPGs. Artificial propagation and domestication trials of *N. jatamansi* are currently being carried out by the UWIFoRT in collaboration with Terra Himalaya, a registered FDI company in Bhutan, which is expected to reduce pressure on wild harvests and enhance *ex-situ* multiplication of the species sufficing the trade requirement.

8.2. Do existing management measures adequately mitigate (= reduce the severity of) the harvest impacts and trade impacts identified?

Yes, management measures are in place to adequately mitigate the harvest and trade impacts. The FNCA (2023) allows the collection and trade of the species with prior approval from the Management Authority (DoFPS). Sections 142 and 143 of the FNCA permit the harvest of NWFP guided by the Management Plan approved by the Department of Forests and Park Services for communities whose livelihood depends on NWFP for commercial purposes. The formation of NWFPGs shall be guided by the Forest and Nature Conservation Code of Best Management Practices in Bhutan (FNCRR, 2023).

STEP 9. NON-DETRIMENT FINDINGS AND RELATED ADVICE

The analysis of current NDF indicates that Bhutan has a stable population of *N. jatamansi* fairly distributed throughout the country with an estimated population of 73,603,770 individuals resulting in 2,054 mt of growing stock in wet form which is equivalent to 350 mt in dried form. To obtain 1 metric ton of plants in wet weight, approximately 35,842 individual plants need to be collected. Accordingly, to achieve a weight of 1 metric ton in dry weight, approximately 210,394 individual plants are required.

Ghimire et al. (2008) reported that harvest rates (<10% in rocky habitats and <25% in meadows) with long rotation periods of (at least 5 years) between successive harvests are prescribed for successful recovery of the species.

This Non-Detriment Finding (NDF) recommends an annual harvest limit of only 4% of the growing stock, with a rotation period of 5 years cumulating to 20% harvest at the end of the fifth year. The annual harvest limit is 82 mt from the wild in wet weight equivalent to 14 mt in dried form and 371 kg of essential oil form for trade. The minimal harvest percentage and the rotation period are employed to mitigate the intrinsic biological risks and anthropogenic threats faced to the species' survival. Consequently, this sustainable practice will facilitate the species' full recovery, decrease the risk of extinction, and promote long-term sustainability.

This NDF provides a POSITIVE decision for the wild harvest and export of the species.

NDFs ADVICE

- Collection of seeds from the wild population for artificial propagation should be permissible.

- Harvest of Artificially Propagated *N. jatamansi* should be allowed without a set AHL. However, it is recommended that the plantations follow the 7-year maturation period.

- The harvest of Artificially Propagated specimens should be physically monitored and verified by the forestry personnel.

- All *N. jatamansi* plantations and distillation units should be mandatorily registered with the DoFPS. It will help to determine the quantity harvested at the source eliminating the inclusion of illegally harvested specimens in legal trade. The DoFPS shall initiate a simple, less time-consuming registration process.

- NWFPGs should be formed in the significant growing areas.

- The NWFPGs and Forest offices in growing areas should be encouraged to raise healthy seeds and rhizomes.

- This NDF recommends October as the ideal collection period for harvesting wild-sourced seeds and rhizomes of *N. jatamansi*.

- Traceability measures will be in place from the origin to the destination inside Bhutan. Relevant documents should be obtained from the Management Authority for the collection and trade of species.

- Develop the *N. jatamansi* framework with a conservation action plan.

- The annual export quota shall be subject to periodic review.

- The estimated AHL of respective parks and divisions as prescribed in *Table 5* shall be divided amongst various registered NWFPGs based on the area of the NWFPGs.

- Illegal trade value accounting for up to 4 mt of dried rhizome shall be deducted from the AHL.

This NDF recommends the following Annual Harvest Limit for the respective parks and divisions.

The estimation of the annual harvest limit/export quota is based on a critical review and analysis of the field data from the nationwide *N. jatamansi* survey, supported by a revalidation survey conducted in Naro and Dotey. The conversion factors are average values derived through analysis of field data and review of literature.

Table 5. *Nardostachys jatamansi* growing sites with their estimated population, growing stock, and annual harvest limit

Sl. No.	Pak/Division	Population	Growing stock	AHL
1	Thimphu	1195444	33	1.3
2	JKSNR	25092715	700	28.0
3	PNP	273913	8	0.3
4	WCNP	5303571	148	5.9
5	SWS	592500	17	0.7
6	Paro FD	1277641	36	1.4
7	BWS	114643	3	0.1
8	Bumthang	1104000	31	1.2
9	JDNP	38649343	1078	43.1
Total				82 mt

Table 6. Annual export quota of *N. jatamansi* in various forms

Sl. no	Particulars	Quantity/Year
1	Rhizomes (wet form)	82 metric tons
2	Rhizomes (dried form)	14 metric tons
3	*N. jatamansi* oil	371 kg

PRINCIPLES APPLIED FOR FIXING THE ANNUAL EXPORT QUOTA

STEP 1. POPULATION: TOTAL NUMBER OF ABOVE-GROUND PLANT INDIVIDUALS/7 (consideration: average 7 rhizomes per clump) = 73,603,770

STEP 2. GROWING STOCK IN GRAM: POPULATION * 27.9g (consideration: average weight of a clump is 27.9 g) = 2053545174 g

STEP 3. GROWING STOCK IN KILOGRAM: (GROWING STOCK in grams/1000) = 2053545.1 kg

STEP 4. GROWING STOCK IN METRIC TONS (wet weight): (GROWING STOCK in kilograms/ 1000) = 2054 mt

STEP 5. ANNUAL HARVEST LIMIT (Wet weight): GROWING STOCK (Wet Weight) x 4% = 82 mt

STEP 6. GROWING STOCK (Dried rhizomes): GROWING STOCK in Wet Weight/5.87 *(consideration: 5.87 kg fresh rhizomes yield 1 kg of dried rhizomes)* = 349837.3 kg

STEP 7. ANNUAL HARVEST LIMIT (Dried rhizomes): GROWING STOCK (Dried Weight) x 4% = 14 mt

STEP 8. ANNUAL HARVEST LIMIT (Oil form): AHL (Weight of dried rhizomes) x 0.026521 kg *(consideration: 1 kg of dried rhizomes yield* 0.026521 *kg of oil)* = 371 kg

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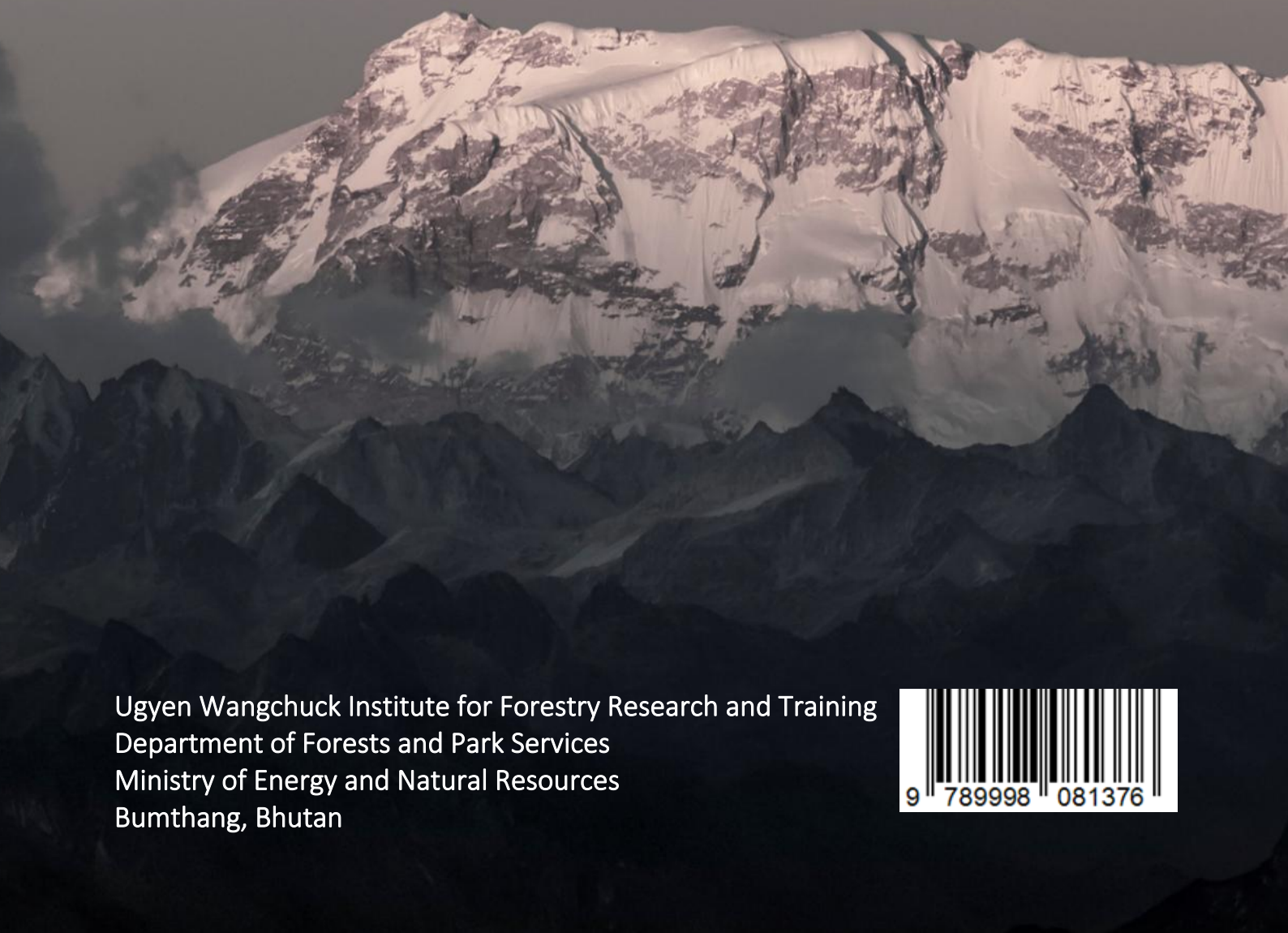

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