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Department of Forests and Park Services

NON-DETRIMENT FINDINGS OF *Aquilaria malaccensis* IN BHUTAN

Ugyen Wangchuck Institute for Forestry Research and Training

Lamai Goempa, Bumthang

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Preface

It is with great pride that Department of Forests and Park Services has come up with the Non-Detriment Findings (NDF) of Agarwood for Bhutan, a document that signifies our nation's commitment to preserving our environment while actively participating in sustainable international trade. Guided by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), this NDF report is a critical tool in assessing the potential impact of trade on Bhutan's Agarwood species and ensuring that this trade remains within scientifically defined and sustainable limits.

Bhutan, regarded for high grade Agarwood within unique ecological landscapes, has deeply rooted Agarwood products in our cultural and spiritual values. As we face growing global pressure and the urgent need for economic development, we also remain committed to sustainable practices of Agarwood production, uplifting the economy of local communities. Agarwood from Bhutan has been not traded at international market due to the lack of NDF. This report presents the potential to upscale production of Agarwood for economic enhancement, while contributing to the global effort to protect natural stands. The sustainable harvest of species is aimed to establish trade levels that will not endanger their populations in the wild. By setting scientifically based trade thresholds, we uphold our responsibilities to CITES and to the world community, ensuring that our resources are managed with foresight and respect for ecological integrity.

This work is the result of a collaborative approach that involved the dedication and expertise of Department of Forests and Park Services, and Agarwood cultivators. They contributed valuable insights that have shaped this report and strengthened its foundations. Together, we are ensuring that our national strategies align with CITES guidelines while addressing Bhutan's unique environmental, social, and economic needs.

This NDF report stands as a testament to Bhutan's role as a responsible steward of its natural resources. As we continue on this path, we reaffirm our commitment to the principles of CITES, dedicating our role as a leader in conservation and sustainable development. We look forward to continue collaboration with the international community to uplift Bhutan's economy, while securing natural agar stand for the benefit of both current and future generations.

Minister
Ministry of Energy and Natural Resources

Foreword

Agarwood (*Aquilaria malaccensis*) holds significant cultural, economic, and ecological value worldwide, including in Bhutan, where it is prized for its aromatic resin and various applications. As global demand for agarwood continues to rise, the importance of sustainable trade practices becomes ever more pressing. This Non-Detriment Findings (NDF) on the agarwood trade represents Bhutan's commitment to responsible management of its natural resources, aligned with the principles of the CITES. Our aim is to ensure that Bhutan's Agarwood trade does not compromise the survival of *Aquilaria malaccensis* in their natural habitats. The harvest of Agarwood products is entirely from private, community, and institutional plantations.

Through scientific study, this NDF provides a guidance for sustainable trade, prescribing permissible harvesting and export quotas that align along with Bhutan's conservation priorities. The findings presented here are, both field data, review of scientific best practices of Agar tree growing regions and traditional knowledge to develop a holistic view of the species' status in Bhutan's forests and plantations. With clear recommendations on trade volumes and management practices, this report seeks to protect Bhutan's agarwood stocks from over-exploitation while empowering marginal famers through sustainable production of Agarwood products.

As Director of the Department of Forests and Park Services, I am proud to introduce this agarwood NDF, which reflects our commitment to environmental conservation, enhance economy, and sustainable management. I would like to express my gratitude to all those who have contributed in developing this NDF. As Bhutan moves forward with agarwood trade, we remain dedicated to continuous monitoring and adaptive management. This NDF is both a valuable resource and a pledge-a clear statement of Bhutan's commitment to sustainable practices in the global agarwood trade and to the protection of our unique biodiversity.

Director
Department of Forests and Park Services

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Executive summary

This Non-Detriment Finding (NDF) report on Agarwood presents a comprehensive assessment of the conservation status, management measures, and trade dynamics of *Aquilaria malaccensis* in Bhutan. The report is structured around key steps including species identification, evaluation of conservation concerns, assessment of intrinsic biological risk, and examination of management effectiveness. Based on this analysis, a series of recommendations are provided to ensure the sustainable management and conservation of *A. malaccensis* in Bhutan.

Species identification and conservation concerns: *A. malaccensis*, listed as Critically Endangered by IUCN, faces severe conservation concerns primarily due to natural habitat loss and illegal harvesting. The species is valued for its Agarwood, leading to high demand and significant pressure from harvesting.

Intrinsic biological risk assessment: Various factors affecting the potential risk of wild harvest, such as plant part harvested, geographic distribution, population size, habitat specificity, regeneration, reproduction, and role in the ecosystem were evaluated. While wild harvest poses a high risk due to whole plant extraction, cultivated populations mitigate this risk. The species exhibits resilience in regeneration and reproduction, with low risks associated.

Effectiveness of management measures: Existing management measures, while providing some protection, are deemed insufficient to fully mitigate harvest and trade impacts. Key recommendations include restrictions on wild harvesting, registration of plantations and industries, promotion of quality planting stock, and research on various aspects of *A. malaccensis*.

Recommendations: The report provides a set of recommendations to enhance conservation efforts and promote sustainable management practices:

- Restrict harvesting from wild and designate remaining stands as genetic conservation areas
- Mandate plantation registration and compliance with CITES regulations
- Promote Agarwood plantation integration and discourage seedling import
- Conduct research on species biology, silviculture, seed collection, nursery establishment, cultivation practices, and value-added product development
- Establish reliable data collection mechanisms and organize awareness programs on CITES

The Ugyen Wangchuck Institute for Forestry Research and Training, designated as the Scientific Authority was tasked by the Management Authority (Department of Forests and Park Services, Ministry of Energy and Natural Resources, Royal Government of Bhutan) to conduct a study and prepare the Non-Detriment Findings (NDF). This study aimed to assess the potential for international trade of certain materials derived from the Agarwood, and to determine the permissible extent of its trade. The products derived from Agarwood include chips, powder, and Agar oil. Additionally, Agarwood is traded in various other forms such as carvings, derivatives, extracts, live plants, timber, timber pieces, wood products, sawn wood, specimens, medicines, and unspecified products, as indicated by the CITES Trade database. However, these products are often grouped with similar items in the ITC-HS classification system, making it challenging to differentiate them under the current system of product classification and coding.

Keywords: ***NDF, Agarwood, Aquilaria malaccensis & Bhutan***

1. BACKGROUND

Agar trees are large evergreen trees that can grow up to 40 meters in height. They have smooth, pale bark and leaves that are simple, alternate, and leathery with a glossy upper surface. The agar tree, also known as *Aquilaria,* is a genus of trees in the *Thymelaeaceae* family. These trees are highly valued for the dark, fragrant resin they produce, known as agarwood, aloeswood, or eaglewood. The resinous compound is believed to be produced by the plant as a self-defense mechanism against fungal infection, although some believe it is produced by the fungus drawing raw material from the plant. The infected plant heartwood is highly prized and used in perfumery, incense sticks, and as a raw material in traditional and modern medicines. Several species of *Aquilaria* exist, with *A. malaccensis* being one of the most well-known and commercially significant.

Due to high demand for agarwood, illegal harvesting in the past severely depleted natural agar tree stands. However, stringent government control over forest harvesting has maintained a better profile for Bhutan compared to other agar-producing countries. This was further complemented by a ban on exports in 1991. Nevertheless, genetically diverse, good-quality seed sources within the natural forests are still available for agar production (CITES, 2003). Consequently, it is currently listed as Critically Endangered in the IUCN Red List (Harvey-Brown, 2018) and in Appendix II (potentially threatened species) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2010).

In Bhutan, *A. malaccensis* (syn. *A. agallocha*) is found in southern broadleaf forests (CITES, 2003). According to Norbu & Chhetri (2008), *Aquilaria* grows naturally in Pema Gatshel, Samdrup Jongkhar, Sarpang, and Zhemgang dzongkhags, usually between 150 meters to 1000 meters above mean sea level. It thrives well in areas with elevations of 500 meters above sea level receiving annual rainfall of 2000 mm. Natural stands and plantations can also be established in other regions of Southern Bhutan (e.g., Dagana, Chukha, and Samtse) where similar conditions exist (Norbu and Chhetri, 2008). In the 1970s, Japan Sahib (Dasho Nishioka) first introduced the plantation of agar trees, and today, over 200 agar trees planted by him are still flourishing in Panbang and from there onwards plantation in private land started. Due to the high value of agarwood, which could enhance better economic stability in the country, the UWICER (then UWIFoRT) initiated efforts to explore the market in 2018. Although MoU for export couldn't be materialized, it encouraged many farmers

in the south. Now, Bhutan has over 543552 agar tree plantations ready to enter the market upon successful fulfillment of required criteria. Internationally, Bhutanese agar is considered to be of very high quality (CITES, 2003).

For the purpose of international trade in parts or products of the species under Article IV (Appendix-II species) of CITES:

i) An export permit shall only be granted when a Scientific Authority of the State of export has advised that such export will not be detrimental to the survival of that species.

ii) A Scientific Authority in each Party shall monitor both the export permits granted by that State for specimens of species included in Appendix II and the actual export of such specimens.

Whenever a Scientific Authority determines that the export of specimens of any such species should be limited to maintain that species throughout its range at a level consistent with its role in the ecosystems in which it occurs and well above the level at which this species might become eligible for inclusion in Appendix I, the Scientific Authority shall advise the appropriate Management Authority of suitable measures to be taken to limit the grant of export permits for specimens of that species; and

iii) A certificate shall only be granted when a Scientific Authority of the State of introduction advises that the introduction will not be detrimental to the survival of the species involved.

The Ugyen Wangchuck Institute for Forestry Research and Training under the Department of Forest and Park Services, MoENR, being the Scientific Authority under the Convention, has been directed by the Management Authority (Department of Forest and Park Services, Ministry of Energy and Natural Resources, Government of Bhutan) to prepare the Non-Detriment Findings (NDF) to examine the possibility of trade and the extent to which it can be allowed.

The study required information on the utilization and trade, and the actual or potential trade impact besides a host of biological parameters. The materials produced from the species and exported fall under the ITC-HS Code 12119080 (Agarwood- including chips and powder) and 33013010 (Agar oil). Besides chips, powder, agar oil, it is also traded in other forms, such as carvings, derivatives, extracts, live plants, timber, timber pieces, wood products, sawn wood, specimens, medicine, and unspecified products (as found from the CITES Trade database). These products are mixed with

other similar products in the ITC-HS classification and cannot be separated under the present system of classification and coding of products.

For estimation of growing stock and regeneration status, a preliminary assessment was conducted and found that Agar saplings/trees are growing in 39 Gewogs of seven Dzongkhags in southern Bhutan. They are mainly growing in plantation areas on privately registered lands followed by State Reserve Forest Land (SRFL), institutional land, community forests, and as natural stands in a few tracts of State Reserve Forests (SRF). A total of 527,173 saplings were enumerated on private land involving 995 households. The highest number was found in Zhemgang, followed by Sarpang, Pemagatshel, Samtse, Samdrup Jongkhar, Chukha, and the least in Mongar. A total of 15,915 saplings were found growing in 18 community forests. The State Reserve Forest Land (institutional land) has 464 trees. The rapid preliminary survey could only record 83 Agar trees in the State Reserve Forest as natural stands.

The trade statistics (both legal and illegal) were obtained from the CITES Trade Database and the CITES Annual Reports. Since there was no approved trade quota for Bhutan or volume/ biomass equations specific to the species were available. Existing equations from other countries did not meet the requirements for Bhutan's population. The current report has been prepared using the available data from the preliminary national agarwood survey and ground truthing in the field.

2. BIOLOGICAL DATA

2.1. Taxonomic classification

Systematic position (APG IV)

Clade: Angiosperms

Clade: Eudicots

Clade: Rosids

Order: Malvales Juss. ex Bercht. & J. Presl

Family: Thymelaeaceae Juss.

Subfamily: Thymelaeoideae Burnett

Tribe: Aquilarieae (R. Br.) Baill.

Genus: *Aquilaria* Lam.

Species: *Aquilaria malaccensis* Lam.

2.2. Common names

English common name: Agarwood, Eaglewood & Indian Aleo-wood

Vernacular names: Aguru (Dzongkha); Agoori (Lhotshamkha); Akuruk (Khengkha),

2.3. Distribution

A. malaccensis is distributed in Bangladesh, Bhutan, India, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, and Thailand. In Bhutan, it naturally occurs in the southern foothills up to an altitude of 1000 meters above sea level composed of tropical evergreen and deciduous trees. The natural population of *A. malaccensis* in Bhutan is represented by 83 individuals growing in two dzongkhags. The plantation population has 543552 numbers of individual trees spread across the Agarwood-growing dzongkhags. Zhemgang dzongkhag has the highest number of plants cultivated in private land, it is widely cultivated in Goshing and Ngangla gewog. It is also cultivated in other *A. malaccensis* growing dzongkhags *viz.* Chukha, Mongar, Pemagatshel, Samtse, Samdrupjongkhar and Sarpang.

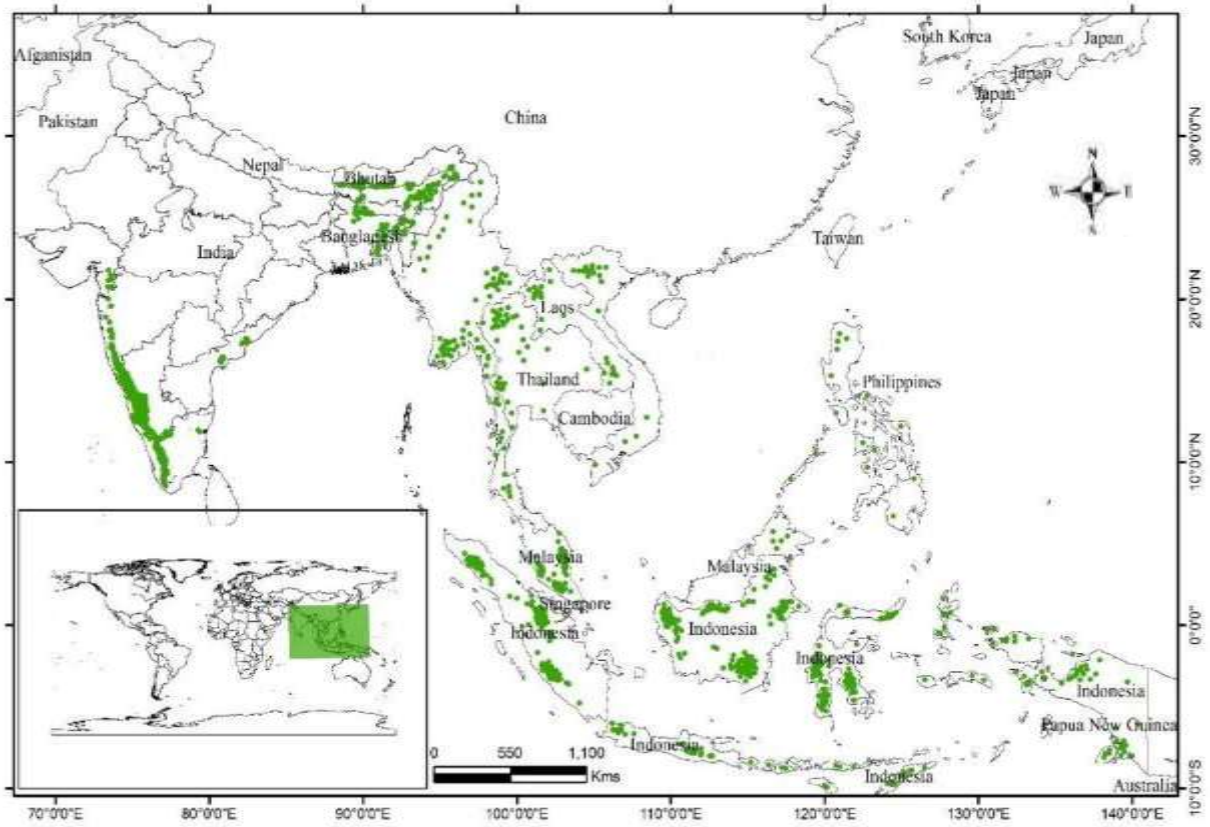

Figure 1. Global distribution map of *Aquilaria species*

2.4. Botanical description

A. malaccensis Lam. is a medium to large-sized shade-tolerant tree, 20-40 m, Wood- light, soft and porous. Branchlets are slender, pale brown, pubescent, and glabrescent. Leaves- simple, alternate; petiole 4-6 mm long; blade elliptic-lanceolate, 7.5-12 cm × 2.5-5.5 cm, chartaceous to sub coriaceous, glabrous, sometimes pubescent and glabrescent beneath, shiny on both surfaces, base acute, attenuate or obtuse, apex acuminate, acumen up to 2 cm long; veins in 12-16 pairs, rather irregular, often branched, elevated and distinct beneath, curving upward to the margin, plane or obscure above. Inflorescence is terminal, axillary or supra-axillary, sometimes internodal umbel, usually branched into 2-3 umbels, each with about 10 flowers; peduncle 5-15 mm long; pedicel slender, 3-6 mm long; flowers 5-merous, campanulate, 5-6 mm long, green or dirty-yellow, scattered puberulous outside; floral tube nearly glabrous inside, distinctly 10-ribbed, persistent in fruit; calyx lobes 5, ovate-oblong, 2-3 mm long, almost as long as the tube, reflexed, densely puberulous within; petaloid appendages 10, inserted at the throat of the tube, oblong or slightly ovate-oblong, about 1 mm long, slightly incurved, densely pilose; stamens 10, free, emerging from the throat of the tube, filamentous, 1.2-2 mm long, episepalous ones longer than the others; anthers linear, obtuse; pistil included; ovary ovoid, 1-1.5 mm long, 2-celled, densely pubescent; style obscure, stigma capitate. Fruit a loculicidal capsule, obovoid or obovoid-cylindrical, 3-4 × 2.5 cm, usually compressed, pubescent, glabrescent, base cuneate, apex rounded; pericarp woody. Seed ovoid, 10 × 6 mm including a beak 4 mm long, densely red-haired, bearing from the base a twisted, tail-like, pubescent appendage as long as the seed (Hooker, 1872; Beniwal, 1989: Grierson & Long, 1991).

2.5. Phenology and reproductive biology

Vegetative phenology of the plant characterizes *A. malaccensis* as a semi-evergreen tree, with leaf shedding and new growth occurring simultaneously. Leaf fall starts in January and leafing starts in the pre-monsoon to monsoon period (March-August). Flowering occurs from April to May. The

flowering is significantly influenced by temperature and rainfall (Borogayary et al, 2018). The fruit sets in about one month in June and the seed matures in about two months from flowering. The duration of fruiting phenophases ranged from 28 to 65 days with an average duration of 46.57 days (Borogayary et al, 2018). *A. malaccensis* is highly cross-pollinated and is pollinated by insects. 10-15% of capsules naturally break open and seeds stay connected to the plant hanging by the funicle cord for 2-4 days till they drop or are dispersed by winds (Manohara, 2013; Borogayary et al, 2018).

2.6. Silviculture of the species:

2.6.1. Silvicultural characteristics:

The most suitable altitudinal range for the growth of *Aquilaria malaccensis* is 300-850 m with a daily temperature range of 19-25 °C (Rabgay et al, 2020). The soil pH of *A. malaccensis* habitat ranges from 5.13-6.69 with a mean pH value of 6.15 indicating a slightly acidic nature (Rabgay et al, 2020). *A. malaccensis* cannot survive in places which experience temperatures below 5°C. It prefers a mean annual rainfall of 2,100-5,500 mm (Rabgay et al, 2020). It is adapted to various types of soil including those that are rocky, sandy or calcareous, but prefers light to medium textured, well-drained and acidic to neutral soil (CITES, 2003). The growth of *A. malaccensis* is predominantly influenced by annual average rainfall in combination with soil pH and mean annual temperature (Rabgay et al, 2020).

The species can thrive under shade and regenerate in patches near the parent tree. The seeds are a recalcitrant type and have a limited dormancy period. Flowering and fruiting start at 5-7 years and each tree produces about 1.5 kg of seeds. Fruit is a capsule with two locules, each having one seed. Seed dispersal is not far from the mother trees. Natural regeneration is usually poor.

2.6.2. Artificial regeneration:

Seeds are collected from mature fruits. Seed collection can be started in June and continued till July. The maturity of a capsule can be determined physically by the easiness of splitting the fruit. For transportation of seed to long distances well-ventilated cloth bags should be used. One kg of fruit will give about 1300 seeds. Seed weight has a strong effect on germination. Germination percentage increases with an increase in seed weight. Uma Shankar (2012), recommended sowing heavy seeds of over 80 mg fresh weight.

Due to its recalcitrant nature, it rapidly loses viability with decreased moisture content. The seed cannot be stored for long and should be sown within a week after collection. Storing in a cool temperature prolongs the viability up to 30 days. The seeds should be soaked in a fungicide solution for 4-5 hours to avoid fungal attack and improve germination. Raised seedbeds are required as seeds are sensitive to high moisture and waterlogging. In a 1 m^2 bed, approximately 300 numbers of seedlings can be planted. Sand medium is recommended for raising the seedlings, and it can be mixed with farmyard manure (FMY). The spacing for seed sowing is 5 x 5 cm. One kg of seeds will produce about 1000 seedlings. The germination rate for the collected seed is 80-90% if sown within a week (Tshering, pers. comm). The seed germinates in an epigeal manner. Germination starts in 14 -20 days of seed sowing and completes within a month. After germination, seedlings of 3-5 cm in height with 2-3 leaves should be transferred to the poly bags (20 x 25 cm) containing sand, soil and FYM in a ratio of 1:2:3.

The seedlings generally attain a height of 30-60 cm in 1-1.5 years. Plantation should be carried out in February-April, resulting in greater survival of the seedling. The spacing of 2.5 m is generally adopted for monospecific plantations. After the seedling transplantation, weeding and clearing should be regularly carried out to achieve better and faster growth. To provide aeration hoeing should be done in a 50 cm radius around the seedlings at 3-4 months intervals. Plantation should be protected from grazing and trampling.

Inorganic fertilizers are applied in *A. malaccensis* plantations that are intensively managed. Good hygiene should be ensured at the nursery site, early growth stage and at the planting site. The seedlings are usually prone to damping and fungal infection. Root infestation caused by soil-borne pathogens are major challenge in the initial establishment of seedlings. Seedbeds should be carefully prepared avoiding too much moisture. Treatment with fungicides may be necessary. The

major pest in *A. malaccensis* is *Heortia vitessoides*, a defoliating caterpillar that retards the growth and leaf tip flea a sap-sucking pest that causes curling of leaves in young seedlings. The intensity of attack by leaf defoliator is substantial during early spring in the months of March-April. *A. malaccensis* in open conditions are more susceptible to this pest as compared to trees under shade. Hand-picking of the caterpillar and destruction of clusters of caterpillars is recommended mitigation measures in small nurseries and plantation sites. RFRI (2023), recommends neem seed kernel extract or green chilly extract applied at 7-14 days intervals as an effective pesticide. Chemical pesticides can be applied in the case of severe infestation but it is not advised as it kill beneficial insect borers associated with Agarwood formation (RFRI, 2023).

2.7. Formation and development of Agarwood:

Natural infection: The Agar formation is caused due to fungus-host interaction, occurring after boring by the larvae of a stem borer, *Neurozerra conferta* Walker (syn. *Zeuzera conferta* Walker). After the boring, natural infection is initiated by certain fungi and bacteria in the wood of *A. malaccensis.* Agarwood formation is also linked to the physical wounding of the trees caused by various natural and anthropogenic agents (Rasool & Mohamed, 2016; Wu et al, 2017). Exposing the inner part of the trees by these agents toward pathogenic microbes elicits the defense mechanism of *Aquilaria* to initiate resin production (Tan et al, 2019). Nonetheless, some reports indicate that the fungus produces the oleoresin while the plant just serves as the substrate. (Adams et al, 2016).

Plants above the age of seven years are usually vulnerable to infection by the fungus. Although various researchers have been studying different aspects of Agarwood formation, the catalyst for Agarwood formation remains unknown. Three fungi responsible for Agarwood formation have been identified by the Rain Forest Research Institute, Jorhat (Borah, 2015). In nature, the fungal infection takes a longer duration to establish. It is reported that only about 10% get naturally infected (Nguyen et al, 1997). The identification characteristics of natural Agarwood formation are the presence of borer holes, oozing of liquids from the new borer holes, closed borer holes having some typical marks, accumulation of frass at the base of the tree, presence of longitudinal cracks and presence of ants in the cracks. The physical identification characteristics are stunted growth, poor crowns, and hollow sounds on hammering.

Artificial induction: Various inoculation techniques are practiced to induce the Agarwood formation in *Aquilaria malaccensis.* The different types of induction methods can be categorized

into mechanical, chemical, and biological methods or combinations. The recommended ideal age for artificial inoculation is 7-10 years. The physical method involves causing physical injury to the plant and allowing infection to take place, by scaring or nailing, partial trunk pruning, burning, chiseling, drilling, cutting and blazing. However, this method can only be successful if sufficient pathogen load is available in the locality.

The first-ever experimental study on artificial inoculation using a chemical method in Bhutan was carried out by the Agarwood Research & Development team of the University of Minnesota (UM), USA and the Rainforest Project Foundation, Vietnam in collaboration with the erstwhile Renewable Natural Resources Research Centre, Yusipang in 2001 (Blanchette et al, 2004). The chemical method necessitates the injection of certain hormones and chemicals into the tree. It is reported that chemical methods cause failure and death of the tree when chemical methods are employed.

In the biological method, the cultured disease-causing organism is injected into the plant. Recent studies by UWIFoRT have revealed that the organic-chemical (biological) approach is reliable and effective, as it is found that both the inducer and the host may produce oleoresins, in addition to their interaction. This validates the higher efficacy of biological methods.

2.8. Regeneration of the species

The natural regeneration of *A. malaccensis* is reported to be poor. The species matures and produces seeds after 5-6 years and seed production peaks when the tree diameter is approximately 40-50 cm. Individual trees can produce up to 19000 seeds per season (RFRI, 2023). The seed dispersal is limited, with more than 65% of seedlings occurring within 5 m of the mother tree. The mortality rate among seedlings is significant, with only 20% of the initial regeneration population surviving after just one year. (Chua, 2008; Soehartono & Newton, 2001; Soehartono et al, 2002).

In monospecific plantations of *A. malaccensis* natural regeneration does not occur, probably due to the tending operations undertaken in them. Likewise, the trees are harvested before they commence profuse seeding. This suggests that without anthropogenic interference, natural regeneration does not hinder the species' reproduction. The commercial plantations generally carry out artificial regeneration using seedlings raised in nurseries that exist with many private agencies and forest departments.

2.9. Population trends

The natural population has drastically reduced due to over-exploitation and illicit felling in the 1970's. There are only 83 mature individuals of wild-growing *A. malaccensis* in Bhutan. During the 4th five-year plan late Dasho Nishioka introduced the villagers to the cultivation of wild *A. malaccensis* in the 1970s (Wangdi, 2015). The plantation of *A. malaccensis* started in the 1980s in Panbang (Wangdi, 2015). 278 numbers of *A. malaccensis* trees planted by Nishioka are still thriving on the left bank of Drangmechhu in Panbang.

Presently, the major population of the species is largely found in cultivation in the native range Dzongkhags. While the natural population is already minimal, the cultivated population is on the rise. The population of *A. malaccensis* in cultivation and natural state as recorded by the Department of Forests and Park Services is given below in Table 1.

Table 1: Population status of *A. malaccensis* in Bhutan

Sl. No	**Category**		**Area (acre)**	**No. of plants**	**Remarks/Locations**
1	Trees grown in natural forests		0.80	17.00	Agoorthang, Manas-Zhemgang
			0.50	20.00	Hatilora ridge, Manas-Zhemgang
			NA	2.00	Agar pong, Chapdempa, Bjoka-Zhemgang
			NA	4.00	Rinchengang, Zarkabla, Bjoka-Zhemgang
			5.00	40.00	Between Longar & Tshar-Tshari, Phibsoo-Sarpang
	Sub-total		**6.30**	**83.00**	
2	Plantations	Pvt. Land	456.01	527,173.00	7 Dzongkhags
		SRFL	0.50	188.00	Plantation created by Darla Research Center at Hathkhola under Norbugang gewog
		CFs	31.72	15,915.00	Plantation inside 15-Community Forests
		Institutional land	0.07	3.00	RNR Compound, Belboteng, Tashicholing-Samtse
			0.50	273.00	ARDC Compound Panbang (Dasho Nishoka plantation)
	Sub-total		**488.80**	**543552.00**	
Grand Total			**495.10**	**543,635.00**	

3. SPECIES MANAGEMENT IN BHUTAN

3. 1. Management measures

3.1.1. *Management history:*

Aquilaria malaccensis was exploited from the southern foothills of present-day Zhemgang dzongkhag in 1960 leading to a major depletion of the wild population. Late Dasho Nishioka introduced *A. malaccensis* cultivation in the country in the 1970s in Panbang, Zhemgang. The Renewable Natural Resources Research Centre in 2001 in collaboration with the University of Minnesota (UM), USA; and later the Rainforest Project Foundation, Vietnam conducted a study on artificial Agarwood production in Bhutan. Currently, The Department of Forests and Park Services is conducting research trials on the inoculation and induction technology of the species with anticipated positive initial results. It is assumed that cultivators of *A. malaccensis* in private land import a lot of inoculums from neighboring countries. Import of inoculum poses a major threat to both in-situ and ex-situ populations which will lead to decimation of the species.

3.1.2. Purpose of the management plan in place:

Currently, there are no management plans for *A. malaccensis*. The Departments of Forests and Park Services have been creating awareness about it as a potential economic source and successfully raised plantations of 543552 numbers within the state-reserved forest and private land. The highest number of *A. malaccensis* is in Zhemgang dzongkhag with a total of 395711 individuals. A systematic plan to raise plantations on a 1-acre land on a 12-year rotation period has been laid out in the comprehensive business plan for Agarwood developed by the Ugyen Wangchuck Institute for Forestry Research and Training.

3.1.2. *General elements of the management plan:*

As of date, there are no management plans for the species in place. Henceforth, the management plan preparation should include the following:

(a) Establishment of nurseries of *A. malaccensis*, both in private and state reserve forest land, for the production of quality planting stock

(b) Identification and management of mother seed tree using the superior germplasm

(c) Establishment of monospecific plantations, and standard rotation cycle, to allow for sustainable harvest every year on a perpetual basis

(d) Adoption and dissemination of organic artificial induction technology of Agarwood by the scientific authority

(e) Improved methods of harvest, processing, value addition, distillation of oil, quality control, and scientific grading of chips as well as oil

(f) Traceability of the material from the cultivated sources, by proper documentation and registration of cultivated sources, which will facilitate obtaining of export permit and also future NDF studies for revision of export quota, if necessary

(g) Development of protocols for product identification

(h) Creation of awareness among the Agarwood cultivators and processing units, about improved methods of cultivation and harvest, processing, marketing and legal requirements

3.1.3. *Restoration or alleviation measures:*

To restore the native population and habitat, enrichment plantation of the species in the original areas of distribution, using seeds from the remaining wild populations is recommended. Plantation needs to be undertaken by the Department of Forests and Park Services, with the assistance of the relevant organizations.

3.2. Monitoring system

3.2.1. Methods used to monitor harvest:

Extraction of *A. malaccensis* from the wild has not been reported in Bhutan apart from the illicit extraction in the past. The Department of Forest and Park Services has geo-tagged all 83 numbers of *A. malaccensis* trees remaining in the wild and received great conservation priority. Currently, the Department of Forest and Park Services is recording the population of agar trees in plantation and SRFL.

3.2.2. Confidence in the use of monitoring:

There was weak monitoring regarding the cultivation or harvest of Agarwood, until now except for some research purposes. Recently, the DoFPS has issued verification to all the agarwood growers to register their plantation with the department.

3.2.3. Legal framework and law enforcement

The Forest and Nature Conservation Act (2023) and Forest and Nature Conservation Rules and Regulation, 2023 presently govern the extraction and utilization of *A. malaccensis* in Bhutan. The Forest and Nature Conservation Rules and Regulations allow the cultivation, collection, and trade of these species (FNCRR, 2023).

4. UTILIZATION AND TRADE FOR BHUTAN

4.1. Type of use (origin) and destinations (purposes)

Agar is used for diverse purposes around the world and is reported in Ayurvedic, Tibetan and traditional East-Asian medical practice, including Shahih Muslim and Susruta Samhita (Barden et al., 2000; Eurlings and Gravendeel, 2005; Gunn et al., 2004; Jensen and Meilby, 2010; Lata, 2007; Mulliken, 2003; Okudera and Ito, 2009; Soehartono and Newton, 2002; Subehan et al., 2005; Uddin et al., 2008; Wollenberg, 2001). In Buddhism, it serves as a major ingredient in many incense mixtures and is considered to be one of the three integral ingredients, together with sandalwood and cloves (Blanchette and Beek, 2005). In Ayurvedic medicine, it is used to treat a wide range of mental illnesses and to drive evil spirits away.

Agar is used in highly processed products such as incense and perfumes (Eurlings and Gravendeel, 2005; Jensen and Meilby, 2010; Lata, 2007; Mulliken, 2003; Okudera and Ito, 2009; Soehartono and Newton, 2002; Subehan et al., 2005; Uddin et al., 2008; Wollenberg, 2001) and also as a remedy for nervous disorders such as neurosis, obsessive behavior, and exhaustion (Blanchette and Beek, 2005). Besides agar oil is used in the preparation of traditional Chinese and Korean medicine, medicinal wine and various other products (Persoon, 2007), and oriental medicine for use as a sedative stimulant, cardiac tonic, and carminative (Bhuiyan et al., 2009). In Japan, it is considered to be sacred and is used to anoint the dead. Furthermore, solid pieces of agar are highly appreciated as “natural art” in Japan, Korea and Taiwan. Craftsmen carve raw pieces of agar into beautiful wooden sculptures, beads and bracelets.

Nowadays, agar is largely used as a fragrance to manufacture beauty soaps and shampoos (Okudera and Ito, 2009; Soehartono and Newton, 2002; Uddin et al, 2008; Wollenberg, 2001). It is also used in the manufacture of cosmetics, used as a flavoring agent in rice, and sometimes used as an insect repellant (CITES, 2004).

It was reported that major world producers of agar are Indonesia and Malaysia (CITES, 2004; Lata, 2007; Mulliken, 2003), and minor producers are Vietnam, Thailand, Laos, Papua New Guinea, India, Bangladesh and Bhutan (Phillips, 2003). The main markets for agar and its products are Japan, the United Arab Emirates, Saudi Arabia, and Taiwan (Chua, 2008; CITES, 2004; Lata, 2007). Bangkok (Jensen), Dubai (Jensen, 2008), Hong Kong and Singapore operate as the largest re-exporter hub for agar and its products (Chua, 2008; CITES, 2004; Mulliken, 2003), and less important markets are Europe and the USA (Chua, 2008), other Arab countries, India, Bangladesh, Korea, and Mainland China (Phillips, 2003).

The uses of agarwood in Bhutan are limited compared to the global scenario. It has been used as a key ingredient in traditional Bhutanese medicines at the Institute of Traditional Medicinal Services (ITMS) and in incense making for centuries (Thapa, 2011).

4.2. Harvest management control (quotas, seasons, permits, etc)

Harvesting of agarwood from the natural stand is restricted. The FNCRR, 2023, allows harvesting and marketing of agarwood from private plantations. Harvesting from CF are governed by CF management plans. As per Thapa (2011), achieving successful agar production in Bhutan faces numerous challenges. These include insufficient financial and technical support on knowledge of infestations, a shortage of experienced and skilled labor (as seasoned workers age), a lack of market information leading to high uncertainty and significant price variations (risking value loss to experienced middlemen outside Bhutan), illegal harvesting from natural habitats, and legal restrictions.

To address this, the Department of Forest and Park Services on July 17, 2023 (Sharma, 2023) issued a public notification on the Registration of Agarwood Plantations requesting all private Agarwood growers in the country to register with the nearest Forest office so that the Department could facilitate and provide necessary technical support about Agarwood plantations and their certification. The certification is meant to provide all necessary technical support for exporting agar since it would require a CITES certificate and permit from the Department. Registering all plantations would allow for sampling to determine growing stock and annual yield, enabling a 10-year harvest quota to be set (FRI, 785001). Such a quota system would ensure the population remains above a certain level and allow for the monitoring of population trends.

4.3. Legal and illegal trade levels

According to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), harvesting agarwood is not prohibited, but all exports and re-exports must be conducted under CITES permits to ensure that international trade does not negatively impact wild populations (Barden et al., 2000). Since 1995, tracking CITES permits issued by exporting and re-exporting countries has improved reporting on the trade of *A. malaccensis.* In 1998 alone, over 1,000 tons of agarwood were reported in international trade under this name (Zich and Compton, 2002).

In Bhutan, Agar species are protected and classified as Special Class Trees under Schedule II of the Forest and Nature Conservation Act of Bhutan, 2023. This schedule allows for the cultivation, collection, and trade of these species according to prescribed rules (DoFPS, 2023). However, due to the **absence of a Non-Detriment Finding (NDF),** Bhutan has been unable to export Agarwood legally. Internationally, Bhutanese agarwood is renowned for its high quality (CITES, 2003). Blanchette and Jurgens noted that Bhutan has been exporting agarwood since the late 1960s, mainly through India to various global markets (Blanchette and Jurgens, 2004). It is also reported that Bhutanese agarwood is frequently exported to nearby Indian states, which acts as a cover for the illegal export of domestic agarwood (Thapa, 2011).

Illegal harvesting and informal trade in the past have significantly depleted Agarwood stands worldwide (Malacca and Agar, 2003). However, stringent government control over forest harvesting has helped maintain a better profile for Bhutan compared to other Agar-producing countries. While gathering information on Bhutanese agarwood, it was observed that contacting Bhutanese traders was challenging because most individuals were involved as collectors or middlemen rather than traders (Thapa, 2011). Those participating in the agar trade in Bhutan lacked direct access to international markets and exporters, relying on middlemen to facilitate trade. Typically, collectors sold to Bhutanese middlemen, who then sold to an Indian contractor in Guwahati or local traders in Rangapani as shown in **Figure 2**. The Institute of Traditional Medicinal Services and incense factories were the only domestic consumers of agarwood.

According to Kuensel online on 24th August, 2023, the cost of Agarwood varies based on its quality and fluctuates over time. The price of one kilogram of Agar resin (locally known as "black") starts at a minimum of Nu 10,000. During the harvesting process, growers noted that the outer white wooden chips also have market value.

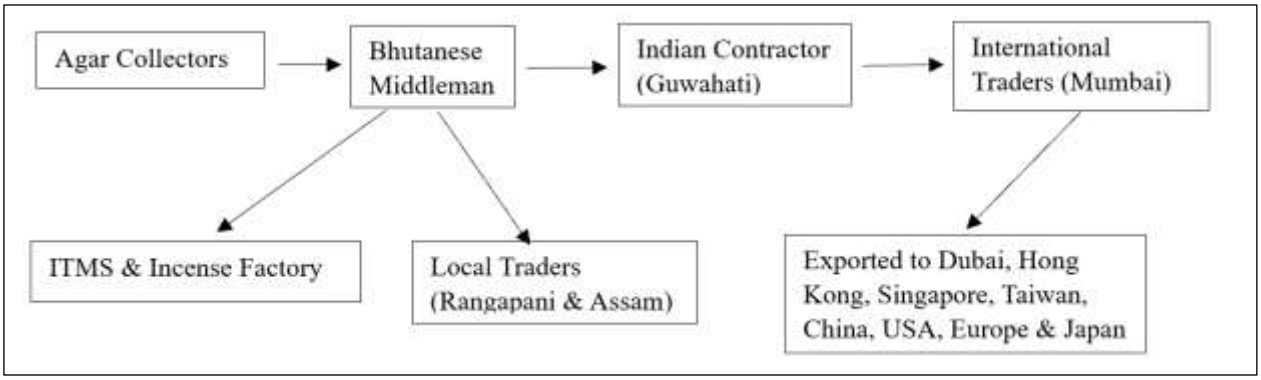

Figure 2. Agar market flow from collectors to traders (Thapa, 2011)

5. NON-DETRIMENT FINDING PROCEDURES (NDFs)

The NDF (Non-Detriment Finding) methodology was initially introduced by IUCN in 2002, as outlined by Rosier and Haywood (2002). Subsequent refinement occurred during the Cancun NDF workshop in 2008, leading to the development of NDF guidance by Rose (2014). Leaman and Oldfield (2014) proposed a nine-step methodology for NDF studies, which was further tailored for perennial plants by Wolf et al. (2016) and for timber species in 2018 by the same authors. This study follows the nine-step pathway established by Leaman and Oldfield. Additionally, following the insights provided by Wolf et al. (2016) and considering the decisions made by the Conference of Parties of CITES concerning Agarwood, the present report has been meticulously prepared and is presented herein.

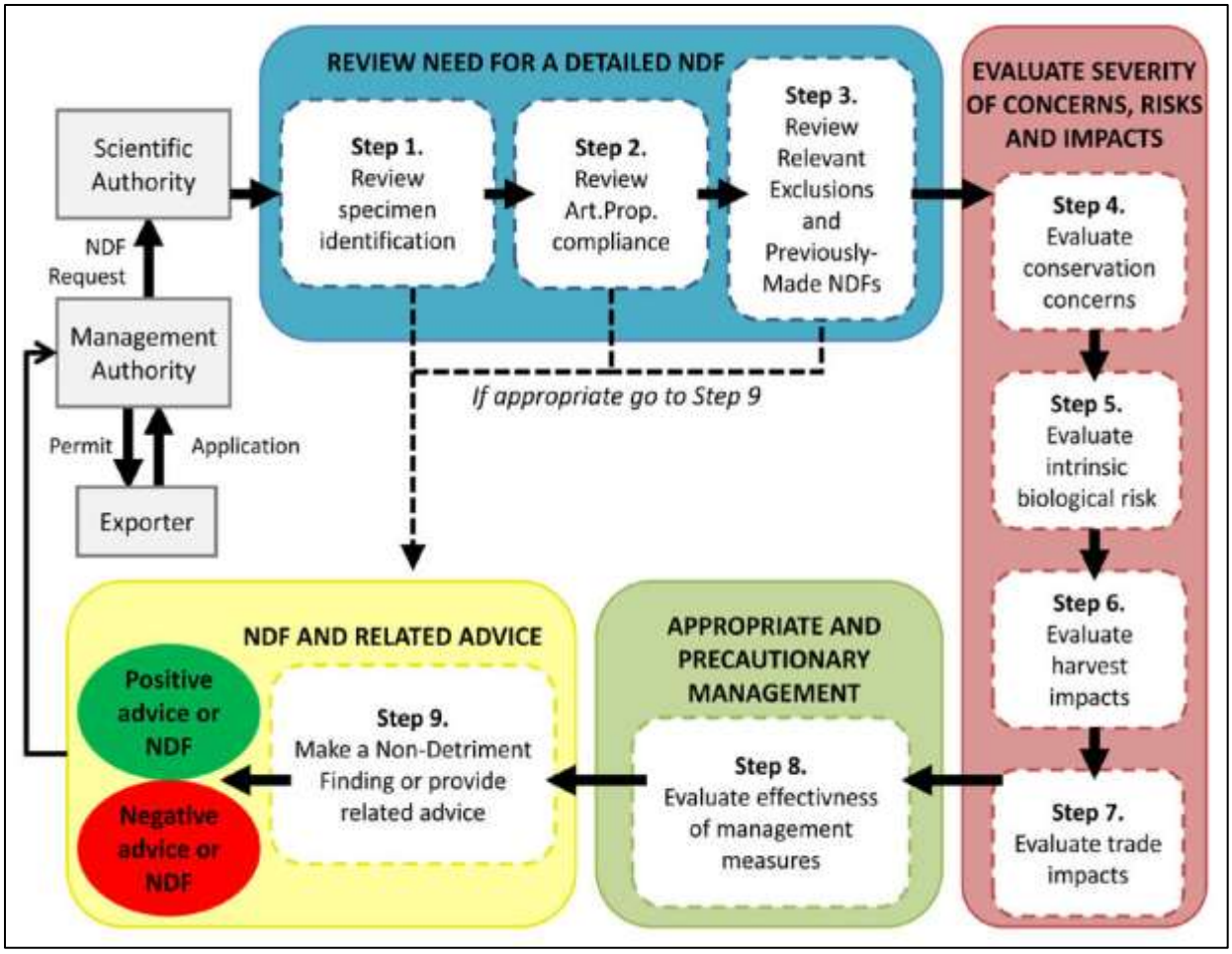

Figure 3. Nine-step pathway for making NDF for perennial plant species listed in the CITES Appendix II (Leaman and Oldfield, 2014).

Step 1: Review specimen identification:

1.1. Has the plant/specimen been correctly identified, and is the scientific name used compliant with the appropriate CITES Standard?

Yes. *Aquilaria malaccensis* is the *Aquilaria* species reported in Bhutan of the three found along its distributional ranges (Grierson & Long, 1991). It is mostly found in plantations and a few pockets as natural stands spreading across seven Dzongkhags: Zhemgang, Pemagatshel, Sarpang, Mongar, Samdrup Jongkhar, Chhukha, and Samtse. The common name of the species in Bhutan is Agar or *Agoor.* The taxonomic classification of the species can be found on the CITES Species Database (http://www.cites.org/eng/resources/species.html), The Plant List (http//theplantlist.org), and IPNI

(http//.ipni.org). The specimens analyzed in this study belong to *Aquilaria malaccensis*. It has been verified that the scientific name utilized (*A. malaccensis* Lamk.) adheres to the relevant CITES standard.

Step 2: Review compliance with artificially propagated requirements

2.1. Is the permit application for artificially propagated specimens?

Yes. Upon the recipient of an application from a private trader to the Management Authority for a permit to trade or export the specimen, the Scientific Authority was requested by the Management Authority to formulate the current study. The applicant specifies in the application that the permit is for the sole purpose of trade or export of cultivated or propagated Agarwood or its derivatives.

2.2. Is export of artificially propagated specimens of this species permitted?

The Forest and Nature Conservation Act, 2023, and Forest and Nature Conservation Rules and Regulations, 2023, permits the cultivation, collection, and trade of specimens upon applying for a permit and issuance of permit by the Management Authority. However, no NDF studies have been conducted on this species, and no export quota has been established pending a positive outcome from the NDF study. Export will pursuant to the terms and prescriptions under this NDF.

2.3. Do specimens clearly meet all the requirements for artificial propagation?

CITES defines the term "artificially propagated" concerning Agarwood in various resolutions including Resolution Conf.11.11 (Rev. CoP15), Resolution Conf. 10.13 (Rev. CoP15), and Resolution Conf. 16.10. According to this definition, "artificially propagated" applies to agarwood plant specimens that are: (a) cultivated under controlled conditions; and (b) cultivated from seeds, seedlings, saplings, cuttings, grafting, marcotting/air-layering, divisions, plant tissues, or other propagules sourced from wild or cultivated parent stocks, as defined in Resolution Conf. 11.11 (Rev. CoP15) regarding "cultivated parental stock". Furthermore, trees of Agarwood-producing taxa grown under cultivation in settings such as gardens or state, private, or community production plantations, whether monospecific or mixed species are regarded as artificially propagated based on the aforementioned definition.

According to Resolution Conf. 11.11. Rev. COP17, plants grown from cuttings or divisions are recognized as artificially propagated only if the traded specimens contain no material from the

wild. However, an exception may be granted, and specimens may be deemed 'artificially propagated' if they are grown from wild-collected seeds, provided certain conditions are met. These conditions include confirmation by the relevant Management Authority of the growing range State that the collection of seeds or spores was legal and by relevant national laws for species protection and conservation. Additionally, it has been determined that: a) the collection of seeds or spores did not harm the survival of the species in the wild, and b) permitting trade in such specimens contributes positively to the conservation of wild populations.

In Bhutan, the natural distribution of *A. malaccensis* is confined to 5 different remote growing areas covering 6.30 acres in State Reserved Forest Land (SRFL) as natural stands. The cultivation of *A. malaccensis* is practiced broadly by methods such as 1) seed collection and nursery raising in home gardens, institutions, and private registered lands, 2) in monospecific plantations within the community forests, institutions, private registered lands, State reserve forest land and home gardens in the natural range of Sarpang, Samtse, Zhemgang, Pemagatshel, Samdrup Jongkhar, Mongar, and Chukhha Dzongkhags.

The planting stock used in these plantations is obtained from private agency nurseries or the Department of Forests and Park Services. Seeds for cultivating the planting stock are gathered from existing plantations and natural mother trees, with the seed collection process ensuring no harm to the species' survival in the wild. Plantations of this species established beyond its natural distribution range unquestionably fulfill the criteria for artificial propagation. Furthermore, homestead plantations, although not directly artificially propagated, exist on private property in non-forest areas. These homestead plantations are akin to artificially propagated populations since the original mother plants from which seeds are gathered for regeneration are themselves artificially propagated. Therefore, the specimens in Bhutan unmistakably satisfy the conditions for artificial propagation.

2.4. Are there concerns about compliance with CITES requirements for artificial propagation that cannot be resolved?

There are no concerns about compliance with CITES requirements for artificial propagation. Outside the natural/wild populations of *A. malaccensis*, more than 99% of the population exists which are artificially propagated. Within the natural range, the population comprises the remnants

of the original wild population, which are quite limited, along with semi-natural populations maintained in home gardens and even-aged plantations throughout the region.

Step 3: Review of relevant exclusions and previously made NDFs.

3.1. Is the export of wild-harvested specimens of this species permitted?

The Forest and Nature Conservation Act, 2023, and Forest and Nature Conservation Rules and Regulations, 2023, permit the cultivation, collection, and trade of specimens upon applying and issuance of permit by the Management Authority. As no previous NDF on the species has been formulated for Bhutan, the current study suggests that despite the provision in the national laws and rules, the wild population should not be harvested at any cost to maintain the species seed bank and genetic composition.

3.2. Is the specimen covered by CITES Appendix II?

Yes. The species *Aquilaria malaccensis* is listed in Appendix II of CITES. It was the first Agarwood-producing species to be included in CITES, being listed at the ninth meeting of the Conference of the Parties (CoP9) on February 16, 1995. Subsequently, the entire genus *Aquilaria* was listed in Appendix II as decided during CoP13 on January 12, 2005.

The current listing stipulates that all species within the genus *Aquilaria* (*Aquilaria* spp.) are included in CITES Appendix II, with annotation #14, effective from January 2, 2017. This annotation regulates the international trade of all parts and derivatives of *Aquilaria* spp., except for the following exemptions:

- Seeds and pollen
- Seedlings or tissue cultures obtained in vitro, in solid or liquid media, transported in sterile containers
- Fruits
- Leaves
- Exhausted Agarwood powder, including compressed powder in all shapes
- Finished products packaged and ready for retail trade
- However, this exemption does not apply to wood chips, beads, prayer beads, and carvings.

Additionally, there is a personal and household effects exemption under CITES [Resolution Conf. 13.7 (Rev. CoP16)]. This exemption allows individuals to carry up to 1 kilogram of wood chips, 24 milliliters of oil, and two sets of beads or prayer beads (or two necklaces or bracelets) per person without needing a permit, provided both the importing and exporting countries implement the personal and household exemptions for the species.

This comprehensive regulation aims to control and monitor the international trade of *Aquilaria* species and their derivatives, ensuring their conservation while allowing for specific exemptions under regulated conditions.

3.3. Has a science-based NDF been made for this species that is still valid and sufficient to evaluate the current application?

No. Until now, no science-based NDF has been developed or formulated for the species. The current study is the first of its kind for the country. However, a detailed assessment of distribution, tree counts, occurrence, and relevant data have been collected and analyzed by the Management Authority. This NDF has been reviewed based on a survey and analysis of the data by the Scientific Authority. This NDF shall be officially in place to guide its harvesting and trade.

Step 4: Review of conservation concerns

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

Yes. *Aquilaria malaccensis* is considered Critically Endangered by IUCN. The Forest and Nature Conservation Act of Bhutan, 2023 enlist *Aquilaria malaccensis* as a Schedule II species.

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

The conservation status of *A. malaccensis* highlights a severe level of concern due to various threats impacting its survival. Globally, the species is listed in Appendix II of CITES, indicating that it is not necessarily threatened with extinction now, but may become so unless trade is closely controlled. The international regulations under CITES aim to ensure that any trade in specimens of this species is sustainable, legal, and traceable.

In Bhutan, the conservation concern for *A. malaccensis* is not assessed. The species is valued for its Agarwood, a fragrant resinous wood used in perfumes, incense, and traditional medicines,

leading to high demand and significant pressure from harvesting. To address these concerns, Bhutan has implemented several conservation measures aligned with CITES regulations:

Regulated trade: Export of wild-harvested *A. malaccensis* specimens is regulated though permitted to prevent the depletion of natural populations. Cultivated specimens from community forests, private registered lands, and State-Reserved Forest Lands are under study or verification to allow for trade, ensuring that the wild populations remain undisturbed.

Geographic separation: The natural stands and cultivated populations of *A. malaccensis* in Bhutan are naturally separated, minimizing the risk of genetic dilution and ensuring the integrity of wild populations. This spatial separation also reduces the chances of diseases and pests spreading between cultivated and wild plants.

Detailed annotations under CITES: The current listing under CITES Appendix II includes annotation #14, effective from January 2, 2017, which meticulously regulates the international trade of all parts and derivatives of *A. malaccensis*, with specific exemptions. These exemptions include seeds, pollen, in vitro cultured seedlings, fruits, leaves, exhausted agarwood powder, and finished products ready for retail trade. By excluding these parts and derivatives, the regulation focuses on the high-value products most likely to impact wild populations.

Personal and household effects exemption: Under CITES Resolution Conf. 13.7 (Rev. CoP16), individuals are allowed to carry a limited amount of Agarwood products for personal use without needing permits, provided both exporting and importing countries recognize this exemption. This measure facilitates the legitimate use of Agarwood while maintaining control over larger commercial trade.

Sustainable cultivation practices: Bhutan promotes sustainable cultivation practices to reduce pressure on wild populations. By supporting community forests and private plantations, the country encourages the production of Agarwood in a controlled and sustainable manner, providing economic benefits to local communities while conserving the species.

Monitoring and enforcement: Rigorous monitoring and enforcement mechanisms are in place to ensure compliance with CITES regulations. The Management Authority is planning to conduct

regular inspections and audits of Agarwood plantations and trade activities to prevent illegal harvesting and trade. The decision to formulate this NDF alone is a testimony to monitoring and enforcement of its harvesting and trade.

The combination of these measures reflects a comprehensive approach to conserving *A. malaccensis* in Bhutan. Therefore, the severity of the conservation of species in Bhutan is assessed as **LOW**.

Step 5: Evaluation of the potential intrinsic biological risk of wild harvest.

Consider the intrinsic biological characteristics that affect the potential risk of wild harvest to species survival. Is the severity of intrinsic biological risk indicated for each of these factors "Low", "Medium", "High" or "Unknown"?

5.1. Plant part harvested and plant life form:

The most critical intrinsic biological factor related to risk is the plant part harvested, as the entire tree is harvested for Agarwood extraction, resulting in **HIGH**-risk severity. Currently, the extraction of trees is limited because the rate of infection and subsequent Agarwood formation is low and scientifically not proven. In Bhutan, the extent of natural Agarwood formation is yet to be confirmed, despite claims of its presence in many areas. In all other regions of distribution, the plant requires artificial induction for Agarwood formation. Without restrictions on harvest quotas or limits on exploitable diameter at breast height (DBH), there is a risk of simultaneously losing large populations through harvest.

5.2. Geographic distribution:

The species depicts a broad distribution spanning from Bhutan in the west to Indonesia in the east. However, across this range, it faces significant threats such as excessive exploitation, illegal harvesting from the wild, and genetic erosion. Considering the natural stands distribution in Bhutan with only 83 numbers in Phibsoo and Manas (Sarpang and Zhemgang) the severity is **HIGH.**

5.3. National/ sub-national population size and abundance:

- **National population size**: A nationwide rapid assessment in Bhutan revealed a total of 543635 Agar saplings/trees spread over 495.10 acres. These trees are distributed across 39 blocks (gewogs) in seven Dzongkhag of southern Bhutan.
- **Sub-national population size by location**:
- **Plantations on private registered lands**: The highest number of Agar saplings/trees were found in plantations on private registered lands in Zhemgang, totaling 527173.00 saplings covering 456.01 acres. Considering the extensive cultivation or plantations, the risk to national and sub-national population is assessed as **LOW** in terms of cultivated/plantations. The distribution by gewog is as follows:

Table 2. Plantation of Agar saplings in private registered land under seven Dzongkhag of Bhutan

Dzongkhag	Numbers of Saplings planted	Area under cultivation (Acres)
Chhukha	407	1.80
Pemagatshel	30514	63.94
Samdrupjongkhar	13370	20.58
Samtse	14456	57.16
Sarpang	72671	135.01
Mongar	44	0.88
Zhemgang	395,711	176.64
Total	**527,173**	**456.01**

5.4. Habitat specificity and vulnerability

The plant thrives at altitudes ranging from 0 to 850 meters and can grow up to 1000 meters in areas with average daily temperatures of 20-22°C. It performs well with a mean annual maximum temperature of 22-28°C and a mean annual minimum temperature of 14-21°C, but it cannot survive in locations where the temperature drops below 5°C. The plant prefers a mean annual rainfall of 1500 to 6500 mm. It is adaptable to a variety of soil types, including rocky, sandy, and calcareous soils, but it prefers light to medium-textured, well-drained soils that are acidic to neutral. The habitat preference is relatively broad, as demonstrated by its successful introductions in high-rainfall zones outside its natural range.

In Bhutan, Agar trees are naturally cultivated in the southern dzongkhags at elevations ranging from 150 to 1000 meters above sea level. These shade-tolerant trees thrive in high humidity and subtropical climates, requiring annual rainfall between 1800 and 3500 mm. In Bhutan, they grow optimally up to 1000 meters above sea level, with an annual rainfall of approximately 3000 to 5000mm, the risk assessed based on the habitat specificity and vulnerability is **LOW.**

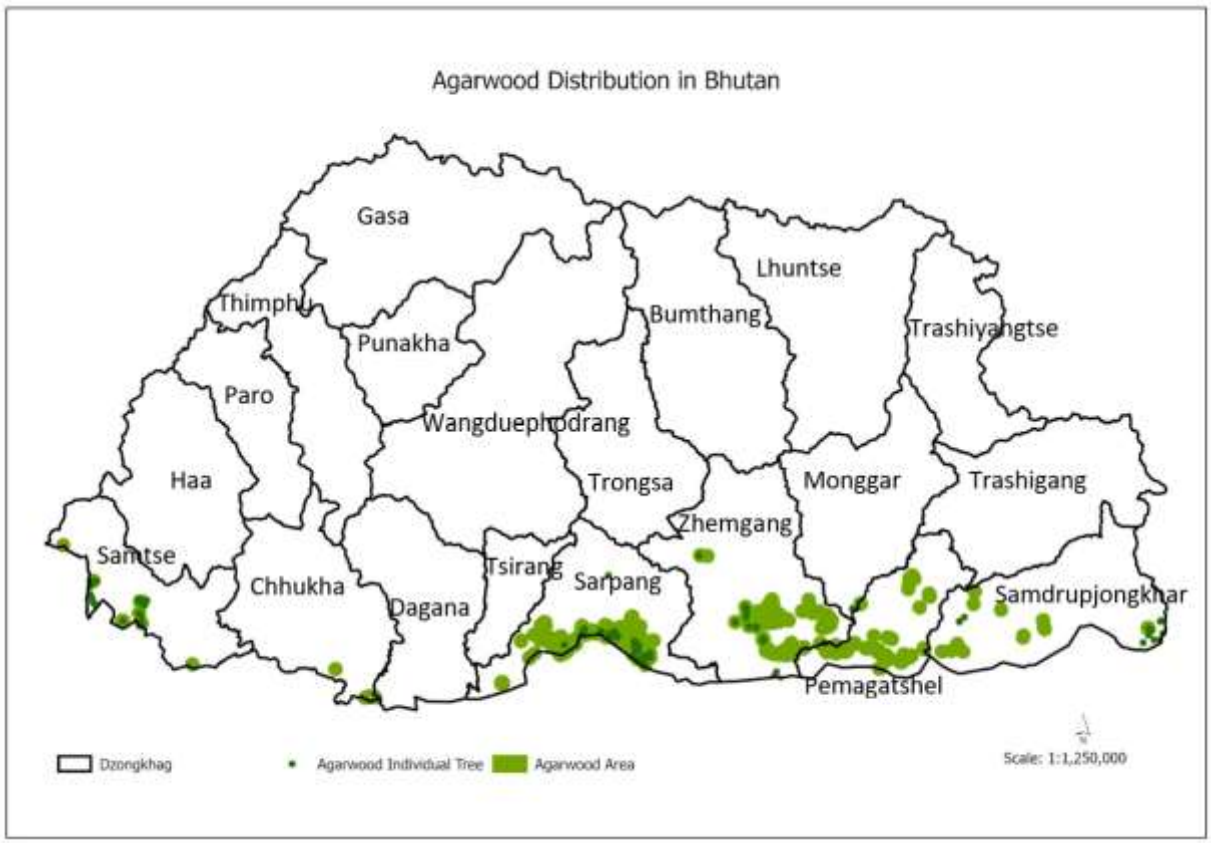

Figure 4. *A. malaccensis* distribution in Bhutan.

5.5. Regeneration

The species is resilient and can be readily restored in its original distribution areas. The success of plantations in semi-natural conditions on private lands, institutions, and home gardens, along with abundant natural regeneration, demonstrates the species' strong regeneration potential if the area remains undisturbed by human activity. The successful artificial regeneration outside the species'

natural range further highlights its adaptive potential. It is also evident from the regenerations observed in its natural stands, the risk associated with regeneration is **LOW.**

5.6. Reproduction

The species reproduces sexually and is commonly pollinated by typical pollinators. Seed dispersal is limited, resulting in young plants regenerating close to the mother plant and forming groups. There are reports of a specialized dispersal mechanism involving wasps. The species faces potential biological risks, such as short seed viability, poor natural regeneration, and susceptibility to defoliators and diseases. However, these issues are largely mitigated in plantations through artificial regeneration and pest and disease management. A risk to genetic diversity arises from commercial nurseries relying on a limited number of seed sources. This risk can be addressed by establishing seed orchards with diverse germplasm near nurseries engaged in seedling production. The risk associated with reproduction is assessed as **LOW.**

5.7. Role of the species in its ecosystem

The species does not hold keystone status, and there are no dependent species or critical functions linked to it. Furthermore, there is no identified specific ecosystem function attributed to this species. The risk associated with its role in the ecosystem is assessed as **LOW.**

Step 6: What is the severity of harvest impact on individual plants, target populations, the national population and other species?

6.1. Impact of harvest on individual plants for the exports requested

The impact of harvest on individual plants for the exports (cultivated or propagated) requested is currently negligible due to the absence of wild harvest. In Bhutan, there are no current records of harvest of this species from the wild. This absence of wild harvest ensures that individual plants are not subjected to the pressures of extraction, thereby safeguarding their populations and genetic diversity. By refraining from wild harvest, Bhutan ensures the preservation of natural ecosystems and the maintenance of healthy populations of this species. The target population for exported currently identified as the ones sourced from cultivation or plantations does not necessarily impact the harvest on individual plants as per the current study and the Scientific Authority advise the Management Authority on the allowable quota of harvest.

6.2. Impact of harvest on target populations for the exports requested

The impact of harvest on target populations for the exports requested is currently minimal, as there will be no wild harvest of the species in Bhutan (only cultivated or propagated). Since there is no targeted extraction from wild populations, the natural/wild populations of the species remain unaffected by harvest pressures. Also, the high number of plantations minimizes the impact of harvest on the specimen population.

6.3. Impact of harvest on national population for the exports requested

The impact of harvest on the national population for the exports requested is currently negligible due to the absence of wild harvest in Bhutan and the targeted population sourced from cultivation or plantations. With no extraction from wild populations, the national wild population of the species remains unaffected by harvest activities.

A nationwide rapid assessment conducted found that a total of 543635 (Five hundred forty-three thousand and six hundred thirty-five) Agar saplings/trees are found growing on 495.10 acres in the 39 (thirty-nine) gewogs (blocks) of the 7 (seven) Dzongkhags of southern Bhutan. They are found to be growing mainly in the plantations in the privately registered lands, State Reserve Forest Land (SRFL), private lands, home gardens, institutional land, community forests, and as natural stands in a few tracts of State Reserve Forests (SRF).

6.4. Impact of harvest on other similar species

A. malaccensis is the only species of *Aquilaria* found in Bhutan, and assessing impact on similar species cannot be assessed due to the lack of similar species. In Bhutan, where there is no wild harvest of the target species, the impact on other similar species is currently mitigated. Harvesting will occur only in the cultivated monospecific plantation sites.

Step 7: What is the impact of legal and illegal trade on the national populations of the species concerned?

In the absence of existing data or reports on trade, both legal and illegal, the specific impact on the national populations of the species concerned cannot be determined. However, it is essential to recognize the potential risks associated with unregulated trade, which may include overexploitation, habitat destruction, and population declines. Without comprehensive monitoring

and enforcement mechanisms in place, there remains a heightened vulnerability to the negative consequences of both legal and illegal trade activities. Therefore, proactive measures such as strengthening regulatory frameworks, enhancing enforcement efforts, and promoting sustainable management practices are crucial for safeguarding the species and its populations in Bhutan.

7.1. Magnitude and trend of legal trade

Due to the lack of available data or reports, the magnitude and trend of legal trade regarding the species in question cannot be assessed. Without comprehensive records or monitoring systems in place, it is challenging to quantify the extent of legal trade activities associated with this species. Additionally, the absence of data makes it difficult to ascertain any discernible trends in legal trade over time. Consequently, further research, data collection efforts, and improved reporting mechanisms are necessary to better understand the magnitude and trends of legal trade concerning the species in question.

7.2. Magnitude of illegal trade

In Bhutan, due to a lack of available data or reports, accurately assessing the magnitude of illegal trade related to the species in question is challenging. Without comprehensive records or monitoring systems specifically targeting illegal trade activities within the country, it is difficult to quantify the extent of illegal trade associated with this species. The clandestine nature of illegal trade further complicates efforts to accurately assess its magnitude within Bhutan's borders. Consequently, there is a critical need for enhanced monitoring, enforcement, and data collection efforts within Bhutan to gain insights into the magnitude of illegal trade concerning the species in question. Such initiatives are crucial for developing effective conservation strategies and mitigating the threats posed by illegal trade within Bhutan's context.

Step 8: Evaluate the effectiveness of management measures

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

Review of legislations

At the national level, the Management Authority controls the issue of export permits, i.e., the Department of Forests and Park Services is the Management Authority in Bhutan. It also collects

the statistics on CITES violations and reports to the CITES headquarters. The ownership of the land where the species grows is either with the state, private landowners, or institutions, and management/protection measures are exercised at all levels. The Management Authority, however, can issue guidelines on the management/protection of the CITES-listed species.

Review of protection measures

The existing forest laws and wildlife legislation provide adequate protection for the species found in forest areas, private lands, and community forests within Bhutan. However, there is a need for increased emphasis on the registration of plantations and industries to enhance monitoring and promote legal trade. The Management Authority should issue appropriate guidelines to the field offices to facilitate this process.

Furthermore, the development of a traceability mechanism is essential to track products to their source, ensuring transparency and accountability in the supply chain. Product labeling and the creation of identification catalogues for agarwood products would assist enforcement authorities in monitoring and regulating trade effectively.

Additionally, there is a requirement for scientific grading, quality control, and valuation procedures to ensure fair compensation for farmers, industries, and exporters. Implementing these measures would help establish standardized pricing and prevent undervaluation, under-invoicing, and tax evasion including geo-tagging of natural stands to ensure the protection of the wild species. Ultimately, the government stands to benefit from increased tax revenue through a more transparent and accountable trade system.

8.2. Do existing management measures adequately mitigate harvest and trade impacts?

The current measures in place are insufficient to adequately address the issues surrounding the harvest and trade of the species. While large-scale plantation efforts across various regions of the country currently mitigate immediate threats to population stability, there are concerns about future sustainability. If plantation activities decline or if existing plantations are extensively harvested to meet the growing international demand for Agarwood products, the species could face significant threats.

To address these challenges, there is a pressing need for the promotion of cultivation in suitable areas, alongside the proper registration of plantations and industries involved in Agarwood production. Additionally, the establishment of silvicultural, seed collection, nursery establishments, harvest quotas, registration of traders and exporters, development of traceability mechanisms, accurate product identification, and appropriate valuation systems are essential. These critical components are currently lacking and require urgent attention from the Management Authority to ensure the long-term conservation and sustainable management of the species.

8.3. The way forward for enforcement

For Bhutan, the following measures are essential for effective agarwood management:

1. **Sustainability**: Ensure continuity of supply through the promotion of agarwood plantations in suitable areas. Periodic assessments of growing stocks and the establishment of harvest quotas from different regions are necessary. Implement the use of Non-Detriment Findings (NDFs) and adhere to the precautionary principle in accordance with international agreements such as CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora).
2. **Traceability and legality**: Enforce compliance with national laws and establish a robust CITES permitting system. Register or certify harvesters, collectors, and traders involved in agarwood trade. Develop registration systems for agarwood plantations, as mandated by relevant resolutions. Intervene at the Dzongkhag to ensure enforcement of these regulations.
3. **Quality and product identification**: Implement measures to regulate the quality and types of Agarwood products traded. Register traders and exporters with the CITES Management Authority and develop product labeling and glossaries for easy identification by enforcement agencies. Establish systems for product identification, grading, and accurate valuation to regulate trade and ensure revenue collection from export/import duties and taxes. Engage the Scientific Authority to develop and implement these systems effectively.

By prioritizing these measures, Bhutan can effectively manage agarwood resources, promote sustainable trade practices, and conserve biodiversity for future generations.

Step 9: Make NDF and provide related advice

I. Non-Detriment Finding of *Aquilaria malaccensis*

From step 1:

9.1. Specimen identification is not clear and/or scientific name is not compliant

In the context of Bhutan, specimen identification is straightforward due to the cultivation of only one Agarwood-producing species. This simplifies the process, as there is a single species involved in Agarwood production. Furthermore, the products derived from this species are easily identifiable, with no records indicating trade under alternative names. This clarity in identification streamlines regulatory efforts and ensures compliance with established standards within the Bhutanese context. Also, the species has been listed in the Flora of Bhutan as *A. malaccensis* (Grierson and Long, 1991).

From step 2:

9.2. Export of artificially propagated specimens of this species is not permitted by national law or relevant subnational legislation.

As of now, the export of artificially propagated specimens of this species is restricted, except for those falling under Annotation #14 (as adopted in CoP16). This limitation is due to the absence of Non-Detriment Findings (NDF) studies and the setting of quotas. However, with this NDF the quotas are established and export permissions may be granted. Furthermore, the Forest and Nature Conservation Act, 2023, and Forest and Nature Conservation Rules and Regulations, 2023 permit the cultivation, collection, and trade of specimens upon applying for a permit and issuance of permit by the Management Authority.

9.3. Specimens covered by export permit application clearly meet all the requirements for artificially propagated according to Res. Conf. 11.11 (Rev. COP 15).

The current inventory largely consists of specimens cultivated on community forests, private land, state-reserved forest lands, home gardens and institutions with seeds for artificial propagation sourced from existing plantations or natural stands. As cultivated specimens are permitted under specific conditions according to national legislation/rules, a **POSITIVE ADVICE** is provided in this NDF report for the export of specimens from cultivated sources.

From step 3:

9.4. The specimen is not covered by CITES Appendix II

The species is listed as Appendix II under CITES.

9.5. Export of wild harvested specimens of this species is not permitted by national or relevant sub-national legislation or regulation.

Wild populations are safeguarded, and the export of wild specimens is regulated. Currently, no export of any specimens from the range is authorized due to the absence of an NDF report and the establishment of quotas. Considering the limited remnant population of the species in the wild, this NDF provides a **NEGATIVE ADVICE** against the harvest of wild populations.

9.6. Evidences used for a previous NDF is still valid and sufficient to evaluate the current permit application.

No NDF was conducted previously, and this is the first such study.

From steps 4-8:

9.7. Do existing management measures adequately mitigate harvest and trade impacts?

The current measures in place are insufficient to adequately address the issues surrounding the harvest and trade of the species. While large-scale plantation efforts across various regions of the country currently mitigate immediate threats to population stability, there are concerns about future sustainability. If plantation activities decline, or if existing plantations are extensively harvested to meet the growing international demand for Agarwood products, the species could face significant threats.

To address these challenges, there is a pressing need for the promotion of cultivation in suitable areas, alongside the proper registration of plantations and industries involved in Agarwood production. Additionally, the establishment of harvest quotas, registration of traders and exporters, development of traceability mechanisms, accurate product identification, and appropriate valuation systems are essential. These critical components are currently lacking and require urgent attention from the Management Authority to ensure the long-term conservation and sustainable management of the species. Furthermore, Resolution Conf. 16.10 urges range states to develop a

registration mechanism for the artificial propagation of Agarwood-producing trees. It also advises exporting states to establish a registration system for exporters dealing with pure or mixed Agarwood oil. Exporting states are required to provide samples of labels used and lists of relevant exporters to the Secretariat, which will then disseminate this information to all parties through notification.

Related advice:

1. Harvesting of *A. malaccensis* from the wild should be restricted. The remaining stands should be identified and safeguarded as genetic conservation areas, preserving the last reservoirs of genetic diversity within the species. In forested areas, existing laws provide legislative protection, while stands located in community forests, should be designated as Community Conservation Areas. Communities should be entrusted with the responsibility of safeguarding these stands, with a clear understanding of the importance of preserving genetic diversity. Encouraging community involvement, including seed collection, nursery establishment, and enrichment planting, can contribute to conservation efforts within forested areas. Furthermore, the import of seedlings from neighboring countries should be discouraged to avoid the risk of introducing new forest pests and diseases.

2. Harvesting from plantations including private, institution, state reserve forest lands, and home gardens:

a) Registration of the plantations with the Department of Forests and Park Services, as determined by national legislation, is mandatory to maintain records of the growing stock for future export quota fixation and revision. The registration, preferably through simplified online procedures, is recommended. The management authority is advised to issue necessary guidance regarding this matter.

b) Agarwood processing industries must register with the appropriate government agency, preferably the Ministry of Industry, Commerce and Employment; Department of Trade, Bhutan Chamber of Commerce and Industry (BCCI) i.e., to track the production of various Agarwood-derived products. This data would aid in determining and adjusting future export quotas. The Management Authority is advised to provide guidance on this matter.

c) Compliance with CITES CoP decisions regarding plantation registration and product traceability must be ensured.

3. In the context of Bhutan, the plantations of *A. malaccensis* should be encouraged through the promotion of quality planting stock and the establishment of plantations. Agarwood Plantation can be integrated into agroforestry systems or used as a shade crop for tea plantations. It is essential to use high-quality planting material obtained from exclusive seed sources such as Seed Production Areas (SPA), Seedling Seed Orchards (SSO), or Clonal Seed Orchards (CSO) established at the Dzongkhag level in non-forest areas. These seed sources should be carefully selected to preserve intra-specific variations and should only be used for planting in non-forest areas to avoid genetic pollution. For forest enrichment, local remnant populations should be utilized as seed sources to maintain the genetic integrity of the species. This approach ensures sustainable Agarwood cultivation while preserving biodiversity and ecosystem health in Bhutan.

4. In the Bhutanese context, there is a pressing need for research on various aspects of *A. malaccensis*, including:

(i) Studying intra-specific variation in phenology, morphology, physiology, and phytochemistry.

(ii) Investigating the biochemistry of Agarwood formation and the roles of the host, pathogen, and insect borer in resin and oil composition.

(iii) Developing Agarwood-based agroforestry systems.

(iv) Researching cultivation practices, including silviculture techniques, integrated nutrient and pest management, as well as establishing harvest rotation in both native and introduced areas.

(v) Exploring methods for artificially inducing agarwood in areas lacking natural infection, such as identifying effective microbial strains and developing farmer-friendly formulations.

(vi) Improving oil extraction methods to enhance quantity and quality.

(vii) Establishing scientific grading methods for agarwood chips and oil to ensure fair pricing.

(viii) Exploring the production of value-added products like cosmetics, medicines, handicrafts, and incense to boost employment opportunities.

(ix) A detailed biomass equation relevant to the species should be developed to analyze the growth, increment, and carbon storage capacity.

The management authority is urged to promote and financially support research in these areas through collaboration with the relevant agencies.

5. The management authority is recommended to establish reliable mechanisms for gathering statistics, as discrepancies exist in the data regarding the species population, raw material, production, domestic trade, and international trade.

6. The Management Authority is further recommended to organize awareness programs on CITES for the agencies engaged in the cultivation, processing, marketing, and trade of species listed in CITES Appendices. Additionally, regulatory agencies overseeing exports should be included in these programs, as there is a significant lack of understanding among these agencies regarding CITES enforcement at the subnational level.

7. The current quota for harvest and export is determined as follows:

a. Rotation age of agarwood tree (maturity) = 10 years (Tan et al, 2019; Ador et al, 2021)

The maturity age of agar in the tropical regions is reported as 7 years, however considering the difference in geophysical conditions and climate conditions, the rotation age/maturity age is prescribed as 10 years for Bhutan. This is because agar tree after having attained 6-7 years can be artificially inoculated and harvester after 2-3 years (Ibrahim et al., 2018).

b. Total plantations (including privately registered lands, SRFL, community forest, and institution plantations): 543552 Agar trees

c. Number of trees above the age of 10 years in plantations: approximately 50000 Agar trees

d. The scientific review of literature on the approximate amount of: The extant quota for harvest and export is predicated upon the availability of harvestable Agar trees. The stipulated quota for Bhutan Agarwood is delineated as follows:

i. The number of mature trees permissible quantity is prescribed as 50000 mature trees per annum based on the total number of trees growing on the plantation site (excluding wild population) with a maturity age of 10 year.

ii. Agar chips: One mature tree (ten-year-old) is estimated to produce 3 kg of infected agarwood chips/powder (Liu et al, 2013; Borah et al, 2024). This estimate is also backed by the study conducted by Ibrahim et al. (2018) which states that, a 10-year-old agarwood tree can produce **10-20 kg of wood**, which, after processing yield 3-4 kg of chips. Therefore, annual quota for agarwood chips is set at 150,000 kg dry weight for the whole country which means annually 50,000 trees can be harvested considering the rotation period of 10 years with the current existing populations. Considering the average weight of unprocessed agarwood trees (at 15 kg/trees) as per Ibrahim et al. (2018), the weight excepted from 50,000 agarwood trees is 750,000 kg.

iii. Agarwood oil: Given that, each agarwood tree produces **3 kg of chips**, which, when distilled, can yield **10-15 g** of oil (Ibrahim et al, 2018). By opting for oil extraction instead of wood chips production, the annual quota from 50,000 trees is set at **750 kg**.

Conversion factor

Principles for fixing the annual quota

A. Agarwood chips/ infected wood (Source: Liu et al, 2013; Borah et al, 2024; Ibrahim et al, 2018).

- 10-year-old agarwood tree yields = 15-20 kg of agarwood.
- Upon processing yield = 3 - 4 kgs of chips from a single tree.
- Total population of agar tree plantations in Bhutan excluding natural stand = 543552 trees
- Harvesting age of the agarwood is 10 years old.
- Total population (543552 trees/10 years) = 54355 trees/year.
- Therefore, annual quota of agarwood tree harvest is rounded and set at **50,000 tree per year.**

B. Agarwood oil (Ibrahim et al., 2018).

- If 3-4 kg of chips is distilled, can yield = 15-20g of oil.
- From the annual quota 50,000 trees × 3 kg chips = 1,50,000 kg of chips
- Oil yield, using 3 kg of chips yields 15 g of oil (lower bound).
- 150,000 kg3 kg/3 kg chip = 50,000×15 g = **750,000 g or 750 kg.**
- From 50,000 agarwood trees, it is expected to produce approximately 750 kg of agarwood oil, given that each tree yields 3 kg of chips.
- Both agarwood chips and agarwood oil are set at lower bound based on the studies elsewhere in the region due to limited data.

8. The main objective of setting the harvest quota for Bhutan Agarwood is based on the following recommendations:

a. To encourage the development of Agarwood infrastructure including processing facilities, value-added product developments, and packaging units in the country, continuous government support should be provided to attract investment and promote local industry growth.

b. To encourage the development of agarwood infrastructure, including processing facilities, value-added product development, and packaging units, government support should be provided to attract investment and promote local industry growth.

c. It is recommended to explore and establish the market for Bhutan-Branded agarwood to enhance its global presence and demand.

9. Although CoP15 has recommended annual revision, considering the need for proper registration and documentation of the cultivated sources, the registration of processing industries and traders/ exporters, and the development of traceability mechanism and product catalog, which is likely to take time, it is recommended that the quota suggested may be considered for revision annually.

10. For facilitating legal trade and ease business, it is recommended that CITES export permits be communicated with the Department of Trade, Ministry of Industry, Commerce, and Employment, and the Paro International Airport. In future Gelephu Mindfulness City International Airport could also be authorized to allow the passage of agar products for export as the country's second international airport.

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