



**Royal Government of Bhutan**  
**Ministry of Agriculture and Forests**  
**Department of Forests and Park**  
**Services**  
**Social Forestry and Extension Division**



# **Guideline for Management of Agar-wood Nursery and Plantation in Bhutan**

**Social Forestry and Extension Division**  
**Royal Government of Bhutan**

**June, 2020**



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P.O Box 130, Thimphu

Bhutan

## **Foreword**

In 1989, recognizing the growing importance of community involvement in protection and management of forest resources, the Division (today known as SFED) started as the Afforestation Division under the then Department of Forest.

The vision of the Division has always been to empower communities manage forests sustainably for socio-economic and environmental benefits. Since the establishment of the Department of Forests in 1952, the plantation program has always remained a priority program. It is one of the major programs of the Department that directly help achieve the Constitutional requirement of maintaining “a minimum of sixty percent of the total land under forest cover for all times to come.” The Plantation Section in SFED (Social Forestry & Extension Division) is the lead agency on plantation in the country. Apart from providing the technical guidance and support in nursery raising and plantation, the agency plans and facilitates all plantations in the country.

According to the Division’s mandate, this guide developed by SFED is mainly for the management of nursery and plantation of Agar-wood in Bhutan. It provides the necessary technical guidance for Agar-wood nursery and plantation management in the country. Additionally, a preliminary map of where Agar-wood is found in the country, including the known

natural stand and plantation is included in the document. It also incorporates the past Agar-wood research and initiatives carried out in the country and the lessons learnt in other countries.

SFED has always worked on programs where community participation has remained the focus in sustainably managing our forests and this guide is one of the tools developed by the Department to facilitate the process.

The guideline is developed not only to support the Government agencies but also to any private or public entity that might want to establish Agar-wood plantation in the country.



**Lobzang Dorji**

(Director)

Department of Forests and Park Services

## **Acknowledgement**

This Agar-wood guideline is developed as a guide for the management of nursery and plantation of Agar-wood in Bhutan. It provides the preliminary map of where Agar-wood is found in the country including the known natural stand and plantation. It incorporates the past research initiatives carried out in the country and the lessons learnt in other countries.

The Royal Government of Bhutan provided the financial support for the development of this guideline.

We thank everyone involved, who helped produce this guideline, especially the SFED and the Directorate, as listed below:

1. Mr. Lobzang Dorji, Director - DoFPS
2. Mr. K.J. Tempel, Chief Forestry Officer - SFED

We would also like to thank UWICER (Ugyen Wangchuck Institute for Conservation and Environment Research) for the available data on Agar-wood plantation in the country and to FRMD (Forest Resources Management Division) for providing the map.

### **Agar-wood guideline development team**

1. Mr. Mr. Sithar Wangdi, Sr. FO
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## Executive Summary

Agar-wood is the resinous wood produced from the genus *Aquilaria* in the plant family Thymelaeaceae. The value of the tree is not in the use of the wood for timber but for the dark resinous aromatic heartwood that is used for medicine, perfume and incense.

It is one of the most promising non-timber forest products in the world. The resinous wood is produced under very special circumstances and its occurrence is very rare. Illegal harvesting and the destructive extraction of Agar-wood, by felling and splitting them, have resulted to depletion of Agar trees in the wild.

Plantation of Agar trees and production of Agar-wood is expected to reduce the pressure of illegal Agar-wood extraction and destruction of natural stands. For the sustainability of *Aquilaria* species in the wild, trail plantations were carried out in the country since the 1980s.

Increasingly, private entities and community forestry groups are following suit and carrying out Agar tree plantations in the country. Therefore, the need to provide the technical guidance and support in nursery raising and plantation was deemed necessary.

According to the Division's mandate, this Agar-wood guideline is developed by SFED as a guide for the management of nursery and plantation of Agar-wood in

Bhutan. It provides the necessary technical guidance to Agar-wood nursery and plantation in the country. Additionally, a preliminary map of where Agar-wood is found in the country including the known natural stand and plantation is included in the guidance document for information. It also incorporates the past Agar-wood research and initiatives carried out in the country and the lessons learnt in other countries.

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## 1. Background

### 1.1. Agar-wood

Agar-wood is a valuable resinous wood that is produced from *Aquilaria* species, an evergreen tropical tree species. It is one of the most promising non-timber forest products (NTFP) in the world. They are referred to as “black gold” (Barden et al. 2000) and considered the most expensive wood.



Figure 1. Agar-wood

Source: <https://sadaharitha.com/products/agarwood/>

The value of the tree is not in the use of its wood for timber but for the dark resinous aromatic heartwood (as shown in Figure 1). The natural production of Agar-wood in the wild takes many decades and is rare.

The resin is produced in matured trees through special ecological circumstances of the tree, the wound on the

tree and the fungi. It is high in organic volatile organic compound with good fragrance and has been traded for thousands of years.

Agar-wood is well known for its extraordinary aromatic properties and has three principal uses. They are most commonly used as essential ingredients to make medicines, perfumes and incense.



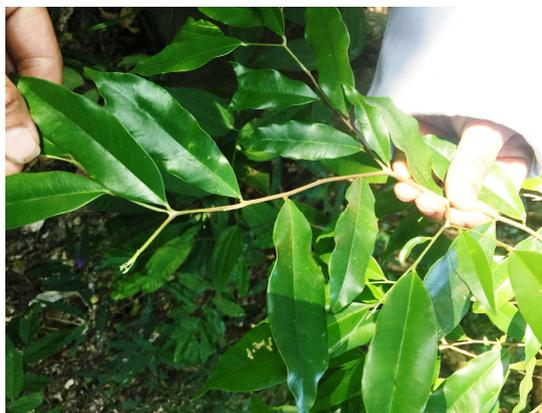
Figure 2. Matured *Aquilaria* species

## 1.2. Agar Tree

The Agar tree is an evergreen tropical species that reaches a height of 30-40 meters upon maturity of the genus

*Aquilaria* in the plant family Thymelaeaceae.

Figure 2 shows a picture of a mature



*Aquilaria*

Figure 3. Leaves of *Aquilaria* species

species in its native habitat in Phibsoo Wildlife Sanctuary, Sarpang.

It has elliptic – lanceolate leaves that are glabrous with close parallel lateral veins (Figure 3).

### **1.3. Distribution**

*Aquilaria* is a fast growing, tropical forest tree found in South and South-East Asia from the Himalayan foothills to the rainforest of Papua New Guinea. The countries such as Bangladesh, Bhutan, Cambodia, India, Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam have Agar-wood production. They are known with different names depending on the region where it is found such as Agar, agura, aloeswood, eagle wood, agallocha and various others.

There are fifteen known species in the genus *Aquilaria* and eight of them are known to produce Agar-wood. The Agar-wood produced from *Aquilaria malaccensis* is considered of high quality in the international market.

The high value of the resin coupled with illegal harvesting has led to severe depletion of its population in the wild. Not all *Aquilaria* trees in a natural stand produce the valuable resin with only one in 100-200 *Aquilaria* trees growing in old growth forests may have the resin (Gibson, 1977). Agar-wood is extracted by felling the trees and splitting them to reveal the resin, if any. There is no reliable means to identify the *Aquilaria*

tree with Agar-wood. Therefore, numerous other *Aquilaria* trees are destroyed in the process.

To achieve a sustainable supply, entrepreneurs and farmers in Asia have started to grow Agar tree in large plantations as monoculture and as agroforestry crops. The first commercial plantation started in 1980s when Vietnam planted 18,000 hectares of *Aquilaria crassna*. Many countries in South and South-East Asia have already started to venture into profitable long-term Agar tree plantation, strengthening the conservation of the natural *Aquilaria* trees.

## **2. Bhutanese Context**

### **2.1. Distribution in Bhutan**

*Aquilaria malaccensis* or *aguru* (common name in *Bhutan*) is native to Bhutan and mostly found in natural habitats spreading over seven Dzongkhags/Districts (Zhemgang, Pemagatshel, Sarpang, Mongar, Samdrup Jongkhar, Chhukha and Samtse).

In Bhutan, they are grown naturally in the southern Dzongkhags within 150-1000 meter above sea level. Agar tree is a sun-loving tree that prefers high humidity and sub-tropical climate with rainfall of 1800-3500 mm per annum.

In Bhutan, it grows well up to 1000 meter above sea level with annual rainfall ranging from about 3000-5000 mm (Wangchuk, 2009). They love growing on hilly

slopes with acidic soil and prefer well-drained deep sandy loam-to-loam soil. However, they can also be profitably grown in marginal soil.

Although, it is listed as protected species, comprehensive information on the population status and spatial distribution of Agar trees in the country is not available. However, from a study conducted in 2009, a total of 7,387 plants were counted with 2,341 in the wild. They were found in various habitats such as: plantations, research plots, nurseries, home gardens (traditional agroforestry practices) and in the wild (Wangchuk, 2009). Plantations in the country started as agroforestry crops introduced as early as 1970s.

With the available data, a distribution map of the known natural stands and plantation in the country has been developed (Figure 4).

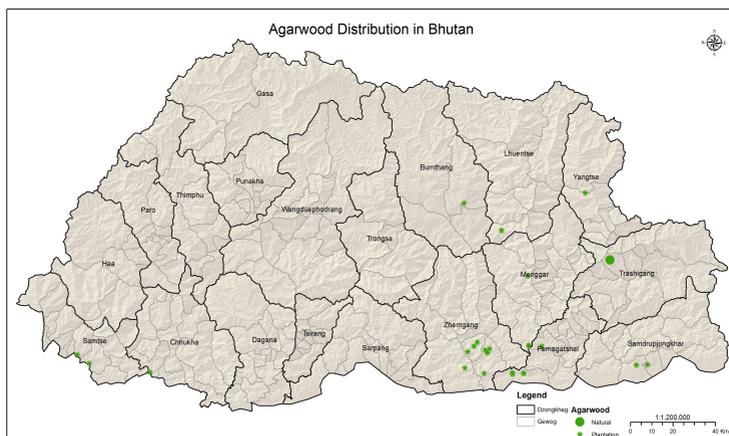


Figure 4. Agar-wood Distribution in the Country

## **2.2. Legal Status of *Aquilaria* Species**

Bhutan is signatory to both CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) and IUCN (International Union for Conservation of Nature). All the *Aquilaria* species falls under Appendix-II of the CITES. It is also mentioned as Red List of Threatened Species of Wild Fauna and Flora under IUCN (IUCN, 2013).

Hence, “International Trade in specimens of Appendix II species may be authorized by the granting of an export permits or re-export certificate. No import permit is necessary for this species under CITES (although a permit is needed in some countries that have taken stricter measures than CITES requires). Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that the trade will not be detrimental to the survival of the species in the wild.”

In Bhutan, it is a protected species and the harvest of Agar-wood in the wild is not permitted. Any trade of transport of Agar-wood in the country will be subjected to the Forest and Nature Conservation Rules and Regulation of Bhutan.

## **2.3. Threats and Challenges**

The high market value of the resin and the destructive illegal harvesting has led to severe depletion of Agar trees in the wild in all the range countries. The Agar-wood is extracted by felling the trees and splitting them,

resulting to felling of numerous other trees as there is no reliable means to identify the *Aquilaria* tree with Agar-wood. Chamling, 1996 notes that although Agar-wood is still found in Bhutan, it is considerably less abundant because of illegal harvests.

In Bhutan, the biggest threat to the sustainability of natural Agar-wood is also destructive illegal harvesting. Bhutanese Agar-wood is considered of high quality in the international market. Since the early 1970s, the demand for Agar-wood from Bhutan has been high and with rampant illegal trade, the natural Agar trees have depleted.

Identification of Agar-wood at species level is generally considered difficult. Both *Aquilaria malaccensis* and *Aquilaria khasiana* are native to Bhutan (Kanjilal & Das 1940, cited in Gupta, 1999; Oldfield et al., 1998). More than one of the Agar-wood producing species of the genus *Aquilaria* occur and is harvested from key *Aquilaria malaccensis* range areas. The studies on identifying *Aquilaria* at species level are underway for the long-term sustainability of the native species.

Except for few known natural stand in our National Parks, majority of the Agar trees found in the country are plantations. The trial plantations were established in Panbang and Samdrup Jongkhar in the 1980s. Though the growths of the Agar trees were successful, the production of Agar-wood was not successful (Chamling, 1996). Inadequate expertise in inoculation and long-

term monitoring of the sites are the existing caveats in producing Agar-wood through plantations in the country.

The major challenges to promoting Agar-wood in the country are the lack of expertise. Though plantation of *Aquilaria malaccensis* is a sound investment for improved socio-economic development and rural livelihoods, currently there is no technical expertise available within the country. We lack capacity in fungus isolation, inoculation and distillation techniques hindering formulation and implementation of strategic measures to propagate the plant for its economic value and genetic conservation.

#### **2.4. Purpose and Prospects**

The initiative to preserve natural Agar trees and promote the development of nurseries and plantation in the country is highly encouraged by the Department. Therefore, to encourage and promote Agar-wood entrepreneurship in the country, this technical guideline has been developed. The purpose of this guideline is to technically guide the planning, management and long-term success of Agar tree plantations in the country.

There are opportunities for regional cooperation with other countries that have the expertise and experience, particularly Cambodia, Vietnam and Thailand who can also aid us in taking this forward and particularly strengthening the technical expertise and the know-how.

With the existing lucrative market for the Agar products, private companies and entrepreneurs venture into the Agar-wood production. This trend has specifically seen in countries particularly, China, Malaysia, Thailand, Laos and Vietnam with large scale plantation of Agar trees.

### 3. General Technical Guidelines

Any Government agencies that plan to develop and manage any nursery and plantations in the country shall be guided by the “Norms and Standards for Nursery and Plantation 2020”. The private individuals can also use the technical guidelines provided here.

#### 3.1. Species and Scientific Classification

*Aquilaria malaccensis* Lamk. is the native species in Bhutan that is recommended for plantation.

**Table 1. Scientific classification**

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Malvales
Family	Thymelaeaceae
Genus	<i>Aquilaria</i>
Species	<i>malaccensis</i>
Botanical name	<i>Aquilaria malaccensis</i> Lamk.

Synonyms	<i>A. agallocha</i> <i>A. secundaria</i> <i>A. malaccense</i> <i>Agalochum malaccense</i>
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### 3.2. Suitable Climatic and Soil Factors

The following ecological characteristics (Table 2) may be taken into consideration for the production of the best quality Agar-wood production.

**Table 2. Suitable climatic and soils factors for Agar-wood production**

Altitudes	Up to 1000 masl
Slope	Up to 45 degrees
Soil texture	Low fertility, stony and deep soil (light; medium)
Soil drainage	Free
Soil reaction	Acid, neutral
Annual rainfall	More than 1800 mm per year
Temperature	20-25°C
Humidity	High

## 4. Nursery Development

Agar tree can be planted or propagated from both seeds and the seedlings.

### 4.1. Seed Collection

- i. The seeds should be collected from the native seed tree of an Agar (*Aquilaria malaccensis*) species for adaptability and economic reasons,

- ii. The seeds should be collected from superior phenotype, healthy seed trees or elite trees which have good form and healthy canopy with 30-50 cm DBH or trees above nine years,
- iii. Depending on the microclimatic conditions, the fruits mature by July to August,
- iv. The fresh matured fruits may be collected from the mother trees by branch lopping and shaking method when fruits are still green,
- v. Considering the low seed viability, seeds must be collected and sown immediately after the seed capsules drop to the ground,
- vi. The fleshy fruit capsules are cut open to collect the seeds.

#### **4.2. Seed Storage**

- i. The fresh fruits are dried in the shade for about 2 days till they burst and release the seed or manually crack the fruits to extract seed,
- ii. Normally the seeds start to lose their germination capacity within one week but viability of seeds can be maintained up to two months by storing in a refrigerator (best storage temperature was 10-12° C) which assures a germination rate up to 80%.

#### **4.3. Seed Sowing and Germination**

- i. The seeds should be sown in the nursery immediately after collection,

- ii. The seeds should be sown in nursery beds about 5 mm deep in a mixture of soil, sand and manure,
- iii. The nursery beds are recommended with light shading,
- iv. The seed germinates within 2-3 weeks and normally complete in a month,
- v. The seedlings should be pricked out into containers after 40-45 days of germination or when they attain 3-5 cm tall.

#### **4.4. Nursery Management**

- i. The seedlings should be free from pests and diseases,
- ii. Prevent damping-off of the seedlings in nursery caused by high humidity and the fungal attack,
- iii. The seedlings for the plantation should be healthy and leading shoot must be intact,
- iv. Normally *Aquilaria* species are encouraged to be raised in containers. But bare root planting can also be done if the seedlings are healthy,
- v. The seedlings raised in the containers should be graded and shifted from time to time to avoid deep rooting,
- vi. Care must be taken during loading, unloading and transportation of the seedlings to avoid damages,
- vii. Hardening of seedlings (gradual removal of shades and reduce watering) is necessary and must be carried out for 2-3 weeks before taking to the plantation site.

## **5. Plantation**

### **5.1. Recommended Plantation Sites**

While selecting the plantation site, must avoid; swampy, water stagnant, alum, limestone surface soils. The recommended plantation sites are marginal and degraded land with the following physical parameters.

- i. Optimum altitude range of 0-750 meters above sea level (exceptionally grown up to 1000 masl),
- ii. The slope up to 45 degrees,
- iii. Grown in low fertility, stony and deep soil: clay soil, loamy soil, soft sandy, including poor sandy soil,
- iv. Rainfall more than 1800 mm per year,
- v. Temperature of 20-25°C,
- vi. Optimum soil pH between 4-6 and
- vii. High humidity areas.

### **5.2. Planting Specifications**

The success of plantation depends on multiple factors such as planting season, soil preparation, seedling quality and management of the plantation. Ideally plantation is done during March-April when new buds sprout. However, in Bhutan, plantations are carried out during the onset of monsoon (May-June) considering the availability of water.

- i. The recommended seedling size is 40-60 cm height and container must be removed at the time of planting and appropriately disposed,

- ii. The planting pits should be dug at least 2 weeks prior to planting for soil oxygenation,
- iii. The planting pits should be at least 30cmx30cm or bigger for easy growth and root adaptation,
- iv. The planting pit must be refilled with the same soil that was removed and the soil should be fine,
- v. The spacing between the seedlings should be 1.5mx1.5m for small scale growers with short rotation period and 2.5mx2.5m for longer rotation period to have bigger diameter which is easier for artificial inoculation,
- vi. The manure supplement is not required because better quality of Agar-wood is obtained from the Agar trees grown in low fertility sites with poor, stony and deep soil.

### **5.3. Plantation Maintenance**

#### **5.3.1. Weeding and Cleaning**

Due to hot and humid climatic condition in the subtropical region, the growth of weed and climber are very fast, thus suppressing the seedling growth. Therefore, a minimum of 3-4 times weeding and cleaning during the first few years after creation is necessary.

#### **5.3.2. Soil Covering**

In the initial stage of the plantation, soil covering around the root system is recommended to avoid washing away of the soils due to heavy rain.

### **5.3.3. Casualty Refilling**

The dead seedlings should be refilled annually.

### **5.3.4. Fencing**

The fencing is required mostly to prevent damage of the seedlings from livestock grazing and wildlife disturbances. The types and pattern of the fencing may vary depending on the biotic pressures and resource availability. The fence maintenance also depends on the quality and type of the material used.

## **5.4. Pests and Diseases Management**

Agar trees grown in the natural environment interact with microbes and insects and are usually not a management concern. However, now the species are introduced in plantations and pest and disease is becoming a growing concern in plantation management. Nevertheless, good management practices adopted from other forest tree species plantations can be borrowed for pest and disease management.

There are four common pests and diseases outlined (Table 3). The signs and symptoms, level of damage and management practices are accordingly described

**Table 3. Common pests and diseases in Agar-wood plantations**

No	Pests & Disease	Signs & Symptoms	Level of damage	Management practices
1	Wood borers (Lepidoptera: Cossidae)	Stunted crown development, swelling/depression & cankers on the bole, and appearance of dieback symptoms/decay top branches	Moderate (kills young plants during severe infestation, as the hollowed trunks are vulnerable to breakage.	(1). Trimming and removal of infected branches. (2). Application of liquid-based pesticides
2	Leaf defoliators (Lepidoptera: Crambidae)	Appearance of brown, wilted leaves, coupled with a mixture of frass and silk web	Major (feeds on young shoots and stems disturbing growth.	(1). Organic pesticides (plant extracts from Capsicum annum, Allium sativum, neem and soursop. A entomopathogenic bacteria & entomopathogenic fungus. (2). Overturning and burning of top soil during cold season. (3). Biological control using natural predators, Sycanus dichotomus, Oecophylla smaragdina and Polistes spp.

**Table 3. Common pests and diseases in Agar-wood plantations**

No	Pests & Disease	Signs & Symptoms	Level of damage	Management practices
				(4). Mix-planting between <i>Azadirachta indica</i>
3	Sap suckers (Hemiptera, whiteflies)	White fluffy spots beneath the leaf surface and presence of sooty mold fungus	Moderate (infestation could make the plant less vigorous, and cause mortality to young plants)	(1). Oil emulsion spray consists of 1:1 of 500 ml soap water and oil, (2). Manual leaf removal on infected region. (3). Water spray to remove insect. (4). Planting of other flowering trees to attract natural enemies. (5). Chemical spray (diluted malathion)
4	Damping off disease	(1). Poor seedling emergence. (2). Young shoots and leaves show irregular stain-like patches. (3). Leaf decay/rotting & dying root tips.	Minor (Premature death of young seedlings)	(1). Biocontrol (arbuscular mycorrhizal fungus <i>Glomus fasciculatum</i> to control <i>Pythium</i> 's attack). (2). Prevention through use of pathogen-free seeds, media

**Table 3. Common pests and diseases in Agar-wood plantations**

No	Pests & Disease	Signs & Symptoms	Level of damage	Management practices
		(4). Browning or rotting of non germinated seed. (5). Rots near the stem collar.		and water. (3). Raising pots one meter above ground. (4). Use of fungicide containing thiabendazole, captan, benomyl, and thiram

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