



Agarwood Oil Extraction Methodology

(from local practices of Koh Kong province)

Project Title: Advancing Restoration of native Agarwood - *Aquilaria crassna* and *A. malaccensis* – for Sustainable Use and Management in Southwestern Cambodia.

AFoCO/038/2023

Co-written by:

Lic Vuthy, Vann Vean, Meng Channa, San Sovannary, Team of Forestry Administration Cantonment of Koh Kong province, and La Yah Ya (LYA Oil Extraction Enterprise, Koh Kong Town)

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Abbreviation

AFoCO	Asia Forest Cooperation Organization
CF	Community Forestry
FA	Forestry Administration
FAC	Forestry Administration Cantonment
NAS	Native Agarwood Species
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries

1. Introduction

Having seen degradation of Native Agarwood Species (NAS) in the forest areas of Community Forestry (CF), e.g. the last 20 years, especially during the decade of the 2010s, the Forestry Administration (FA) and the Asia Forest Cooperation Organization (AFoCO) have collaboratively worked to restore the NAS under the project entitled: “Advancing Restoration of native Agarwood - *Aquilaria crassna* and *A. malaccensis* – for Sustainable Use and Management in Southwestern Cambodia”, known as AFoCO/038/2023. The project timeframe is 01/06/2023 – 31/05/2026 (three years). The project is aiming at:

1. Rehabilitation of former Agarwood ecosystems as the country piloting areas.
2. Awareness-raising on advancement of native Agarwood restoration in Southwestern Cambodia.
3. Establishment of effectively enabling environment to support the development of Family-scale and private sector in native Agarwood species plantations.

The project activities are restorations of NAS by planting the species on the areas of Community Forestry sites, Family-scale plantations, and private companies of the Cardamom Mountain, Southwestern Cambodia, in the provinces of Koh Kong, Kampong Speu, Pursat, and Battambang.

The Oil Extraction Methodology was written in order to share knowledge and experiences on oil technical extraction from Agarwood plantation till final products - oil. The document is expected to motivate relevant stakeholders such as owners of Agarwood plantations (Family-scale and companies), especially members of CF, to increase their Agarwood plantations, using NAS in particular, for its sustainable utilization and management while restoring the species in the wild of its former habitats, particularly in the CF areas. It is recommended that the document shall be kept in the project relevant offices such as FA, Forestry Administration Cantonment (FAC), CF, and Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) encouraging them to plant more Agarwood trees and, by benefiting from the document, produce more Agarwood oil for markets. In return, demand of Agarwood chips from the wild would be reduced, or sustainable collections of the wild Agarwood could be maintained.

2. About the Agarwood Species

Two NAS – *Aquilaria crassna* and *A. malaccensis* have naturally grown in the Cardamom Mountain, Southwestern Cambodia, even though records states that four NAS has been growing in Cambodia as a whole (Chhang Phourin, pers. Com.). Nevertheless, Lic (Lic et al., 2023) found only three species (see photo). Oil products of *Aquilaria crassna* and *A. malaccensis* are among the most frequently present in all trades in Cambodia while the third one – *A. rugosa* – has been naturally rare. The latter has found only in Eastern Cambodia, but has not yet in the Southwestern Cambodia, where the project is implementing.



Photos of: *Aquilaria malaccensis* (two Left), *A. crassna* (two Center), and *A. rugosa* (Far Right)


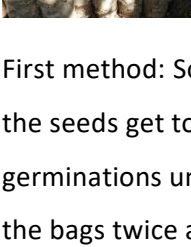



There is no different odor (smell) among the oils of the two species. However, *Aquilaria crassna* provide more often resin than *A. malaccensis*. There is no agreed explanation on how the Agarwood resin formed, even though research found that Agarwood could naturally only produce resin at about 15 years or more (Nha Le Hoan, 2023). Agarwood resins normally are gray or light black. The resin produces strong smell when burnt. The resin can, also, be extracted as oil (liquid) through processes of grinding, soaking, and distilling (boiling). Because the wild NAS has been decreased in the forests, plantations, especially introduced Agarwood seedlings from neighboring countries like Thailand and Vietnam, have increased in Southwestern Cambodia, e.g. Koh Kong province. There are two types of Agarwood plantations – companies and Family-scales. All the companies used introduced Agarwood seedlings while Family-scales used either introduced or second or third generation seedling of the NAS.

The companies use chemical substance, with no detail information available from the companies, for inoculations. Planted Agarwood trees could be inoculated at the age of 8 years old. Inoculations could be either on the company or Family-scale plantations, but the companies normally are the experts in inoculations. Agarwood trees have to be cut down at year three (03) after inoculation time otherwise the resins would content less oil. Many more inoculated holes could have on larger trees than on smaller ones; leading larger trees could have more resin. Resins could be locally named differently depending on content of oil in each resin pieces (Photos below).

Similar to general tree plantations, Agarwood plantations are necessary to be taken care. Taking care of the Agarwood plantations include water, pesticide, and fire prevention. It is worth noticing that utilization of

insecticide could also affect on young Agarwood plantations, especially during periods of inoculations. Pesticide utilization within the Agarwood plantations should be prohibited at least during one week after inoculation of Agarwood trees. Outside people may, also, import disease to Agarwood plantations.

The following steps are about nursery, plantation, and maintenance of Agarwood plantations.

	<p>Photo A1: Seedling-bag soil: Soils should be a mix types of termite mound soil or dry-river mud soil, cow dung, and rice-husk ashes.</p>
	<p>Seeding Technique: Seeds should be son-dry out for three days after seed collection.</p> <p>First method: Sow the seeds on either rows of soils or in the bags. Watering the seeds twice a day till the seeds get to germinate. The second method: collect seedlings or sprouts (at their few days age of germinations under the seedlings mother trees) and plant them into bags, one or two per bag. Water the bags twice a day till they are ready for plantations.</p>
	<p>Photo A2: Plantation site: It is worth noticing that Agarwood will not grow on swamp, mud, or sandy soils. Watering is needed for the first month after planting, if no rain.</p>
	<p>Photo A3: Mature Seedlings. Seedlings should be considered as mature if they grow in the bags for about 7 months of age and as high as 50 cm.</p> <p>Maintenance: watering it regularly and take care the seedlings from insects and weeds.</p>
	<p>Photo A4: Inoculation. Agarwood trees could be inoculated at 8 years of age or more. Resin harvest could be done at around three (03) years after the inoculation year.</p>

3. Inoculation and resin collection

The following sections, discussions are only on inoculation and resin collection within Agarwood plantations, not in the wild. It is observed that Agarwood species of almost all the existing Agarwood plantations are *Aquilaria crassna* and *A. malaccensis*. It is, also, observed that Agarwood trees are planted at 2 m by 2 m from one tree to another and 2 m by 2 m from one row to the next.

Drilling Method: Drilling hole should be at 10 to 15 cm apart along the tree trunk, in vertical lines, and at 10 cm from one row to the next across the circumstance of the tree, in horizontal lines. The holes could be alternative from one row to the next in order to keep space for resins to grow. The hole should be angling

(15° compared to flat/horizontal plane) against the trunk stand. The hole should be as 10 cm depth into the tree trunk.

Inoculation Method: Dropping the chemical liquid substance should be immediately done after drilling the holes. See description at Photo A8 for details.



Photo A5: **Liquid chemical substance** for inoculation. The liquid chemical substance could be obtained from LYA company (all right reserved). The company is located in Koh Kong Town, Koh Kong province, Cambodia. The liquid chemical substance is crucially important for the creation of resins. More resins could be obtained if the right liquid chemical substance used.



Photo A6: **screw driver** (manual or automatic) is used for drilling Agarwood stem to make holes before dropping liquid chemical substance into it. The holes could be either drilled or punched with hot irons.



Photo A7: **Holes** on the Agarwood tree trunk/stem and branches. The holes could be alternative from one row to another in order to keep space for resins to grow. The hole should be angle (15° compared to flat/horizon) against the trunk stand. The hole should be as deep as 10 cm into the tree trunk. Drilling could be divided into two stages: the second drill should be at about 8 (eight) months after the first drilling time. About 80% of the total holes should be made during the first drill and another 20% should at the second stage. Liquid chemical substance may not need to drop into the hole at the second drill stage.



Photo A8: **Inoculation**. As mentioned at A7 above, liquid chemical subsistence should be dropped into the holes. Each drop should contain about 5 CC. It is worth noticed that insecticide and pesticide should not be used in the areas nearby the drilled trees after they are drilled for at least three days because the drugs could kill the trees. Prevention of fire on the trees should be always taken care.

Resin Collection Steps are as following.



Photo B1: **Resin trunk**. Resin trunk is a piece of Agarwood stem cut for collection of resins. Each resin trunk could be 40 cm long. The black spots on the resin trunks are the resins. The resin trunks are chopped for the resins.



Photo B2: **Rough Resins**. Having chopped the resin trunk (Photo B1), the rough resins are the last tree trunk to be further chopped for chips (Photo B3) or for Piece of Resin (Photo B6).



Photo B3: **Chips**. Chips are small pieces (rough size of 3 cm X 2 cm X 0.3 cm) of Rough Resins (Photo B2). About 70% of the chips contains resin. The chips have to be dry before milled into powder called Resin Powder (Photo C2). The Resin Powder is soaked into water (ground water) for 30 days before taking to boil (distillate).

Remark: Experience of LYA Oil Extraction Enterprise, Koh Kong Town, showed that ground water of the Koh Kong Town may consist specific chemical elements, which make Agarwood oil special to the locality, e.g. smell good and different from others.



Photo B4: **Blade**. Different sizes of the Blades are used to peel (take-off) unwanted parts of Agarwood trunks (Photo B5).



Photo B5: **Peeling**. Because resins are small inside the Resin Trunks, peeling is activity to take-off unwanted parts of the Agarwood wood. As the results of peeling, resin (piece of resin) is obtained (Photo B6). Blades (Photo B4) are used to peel.



Photo B6: **Piece of resins**. Piece of resin is the result of peeling. The Piece of resin normally used for burning for getting smells. Piece of resin consists more oil than chip.

4. Agarwood Oil Extraction

In order to have oil products, the following steps are needed.



Photo C1: **Milling machine**. It is used to crunch chips (Photo B3) into powder (Resin Powder, Photo C2). 20 kg of powder is soaked into water of a container (Photo C3).



Photo C2: **Resin Powder**. Resin Powder is the result of milling of chips using Milling machine. Put 20 kg of the Resin Powder into a container (Photo C3), the container volume is 200 liters. Pour water into the Resin Powder-container up until 20 cm of water level above the Resin Powder level. Then, shake it well.

The well-shake-Resin Powder is called **Resin Powder Solution**. The Resin Powder Solution is kept for about 35 days after soaking. During the soaking time, regular shakes, using Shaking Spoon (Photo C4), should be made in order to have a better Resin Powder Solution.

Remark: The LYA company claimed that “ground water” of Koh Kong Town help better smells of the extracted oil.



Photo C3: **Container**. The container volume is 200 litter each. It is made from plastic materials.



Photo C4: **Shaking Spoon**. Shaking Spoon is as long as 170 cm. At the end of the soaking period (after 35 days of soaking), pour the Resin Powder Solution into Distillation Pan (Photo D1).

Duration of distillation could be as many as ten (10) days. As seen on the Oil-Glass Container (Photo D2), if there is no more drop of oil, distillation should be stopped.



Photo D1: **Distillation Pan**. Distillation Pan is used for distillation of oil from the Resin Powder Solution. Two containers (Photo C2) of Resin Powder Solution feed into one Distillation Pan and boil it.



Photo D2: **Oil-Glass Container**. The Oil-Glass Container is used for stockage oil and water vapor that come from the Distillation Pan (Photo D1). Then, oil and vapor are separated.



Photo D3: **Cooling Hand**. Cooling Hand is a tube that placed across Cooling Sink (Photo D4). It connects Distillation Pan (Photo D1) and Oil-Glass Container (Photo D2). Through the Cooling Hand, vapor and oil come Distillation Pan to Oil-Glass Container.



Photo D4: **Cooling Sink**. Cooling Sink stocks cool water; through which oil (and small amount of vapor) is cooling down before reaching Oil-Glass Container.



Photo D5: **Shaking Stick**. Shaking Stick is used for the whole period of distillation. It is connected to cover of the Distillation Pan. About three (03) hours apart, the stick should be shaking during period of distillation.



Photo D6: **Thermometer**. Temperature inside of Distillation Pan should be kept at 100°C at all the time during distillation. The temperature could be measured by the thermometer.



Photo D7: **Metal Tube**. Metal Tube is used for receiving water spilled over from Oil-Glass Container (Photo D2). The spilled-over water may contain some semi-final oil. So, it is returned into the Distillation Pan (Photo D1) for re-distillations.

References

Lic, V., Vann Vean, Meng Channa, and San Sovannary. 2023. Agarwood in Cambodia. Research paper for the AFoCO/038/2023 Project entitled Advancing Restoration of native Agarwood – *Aquilaria crassna* and *A. malaccensis* – for Sustainable Use and Management in Southwestern Cambodia.

Nha Le Hoan. Visited 10/10/2023. <https://tropical.theferns.info/viewtropical.php?id=Aquilaria+crassna>