# Agarwood Oil

## A Case Study on Use of Synthetic Biology Replacements

**Farmers Affected:** Difficult to estimate

**Market Value:** $6-12 Billion US[1]

**Volume:** 4,870 litres/year

**Uses:** Perfume and Cosmetics

**Syn bio Companies:** Evolva, Efflorus

**Hotspots:** India, Indonesia, Malaysia, Vietnam, Cambodia, Thailand, Laos, Papua New Guinea

**Also Grown In:** Bangladesh, Bhutan, Brunei, Darussalam, China, Myanmar, Singapore and Sri Lanka,

**Cultural Importance:** Cultural and religious significance in ancient civilizations around the world - mentioned extensively in some of the world's oldest written texts

**Biodiversity Considerations:** Collection in the wild is endangering *Aquilaria* species (tree), but new intercropped plantations claim to use agroecological practices that benefit biodiversity.

**Quality Concerns:** Natural agarwood oils have many chemical constituents. Syn Bio Companies usually manufacture only one component of the natural product, not all the molecules present in the natural product.

**Method:** Yeast

**Commercialization:** Efflorus' product may be on the market by 2017.

## Overview

Agarwood oil or Oud, a fragrant oil found in the damaged heartwood of Southeast Asian *Aquilaria* trees, has a long and sacred history as an important fragrance used for thousands of years in the religious and cultural ceremonies of ancient civilizations. Unfortunately, the wild collection of this expensive oil is endangering the *Aquilaria* species and so trade in wild agarwood is now illegal. In response, *Aquilaria* plantations are being established to farm agarwood on a more agroecological basis. Two biotech companies (Evolva and Efflorus) have made it known that they are working on producing the main components of agarwood through synthetic biology. At this point neither has a timeline for commercialization, methodology or product names.

**Status: Syn bio agarwood may be available in 2017**

**R&D** **Scale Up** **Commercialization**

## What is Agarwood Oil?

Agarwood (also known as Gaharu or Oud oil) is the fragrant resinous heartwood found in trees from the genus *Aquilaria* (Thymelaeaceae), native to southeast Asia.[2] This highly-prized but endangered aromatic, resinous wood is only formed inside the tree if it becomes damaged or diseased due to cutting, pest or insect disturbance, microbial infection, fire, etc.[3] Agarwood is used to make essential oils for perfumes, and for wood chips to make incense. It is described as "...a high-demand ingredient in fine perfumery due to its warm, unique balsamic notes with sandalwood–ambergris tonalities."[4]

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For more information on Synthetic Biology please visit the ETC Group website:
**www.etcgroup.org/synbio**

## Agarwood as a Natural Product

Agarwood trees traditionally grow throughout South and Southeast Asia,[5] but Malaysia is the major producer of high-quality agarwood.[6] It is not known how many people earn their livelihoods from collecting and processing agarwood – especially because most of the trade is illegal. Foreign nationals as well as locals are reportedly involved in illegal agarwood harvesting in Malaysia.[7]

According to industry sources, the estimated value of the global trade in agarwood is a staggering $6 to $12 billion US.[8] Official figures are not available from any country because most of the trade is black market.[9] High-quality agarwood essential oil – priced wholesale at $15,000 US per liter – has been dubbed "liquid gold." The retail value is often triple that amount.[10] The price of agarwood oil ranges from $100 US/kg for lower quality material up to $100,000 US/kg for superior, high-purity oil.[11] In 2012, global trade in agarwood essential oil was 4,870 litres.[12] Key importers of agarwood essential oil include Saudi Arabia, the United Arab Emirates, Bahrain, Malaysia, Singapore, China, Taiwan and Japan.[14] In 2013, global trade in agarwood chips and powder was 4.7 million kg – the price of agarwood chips ranges from $20 US to $6,000 US per kg; high quality wood sells for up to $30,000 US per kilogram.[13] Major importers include Singapore, China, Taiwan, Japan, Saudi Arabia and the United Arab Emirates.[14]

## Cultural and Biodiversity Considerations

Agarwood has been used for millennia in Buddhist, Hindu and Islamic ceremonies, and also in Chinese, Tibetan and Ayurvedic traditional medicine. Throughout Malaysia the Orang Asli (the area's First or indigenous peoples) are reportedly the most important collectors and primary traders of agarwood.[15] As global demand grows for high-quality agarwood some species are now nearing extinction in the wild.[16]

Because of its threatened status, since 2004 trade in all wild *Aquilaria* species is controlled under Appendix II of the Convention on International Trade in Endangered Species (CITES) of Fauna and Flora.[17]

Not all *Aquilaria* trees contain the valuable resinous deposits, and most people can't tell if a tree contains the resin without felling the tree and cutting it open – actions that further endanger the wild *Aquilaria* trees.

In response, the Malaysian Forest Research Institute Malaysia (FRIM)[18] and private sector investors have established *Aquilaria* plantations;[19] but techniques for inducing resin formation in plantation-grown trees reportedly yield lower-quality agarwood than wild-harvested trees.[20] This could change with research. Beginning in the late 1990s, FRIM collaborated with a New Zealand research company, Industrial Research Limited, to establish trial plantations. In 2015, Singapore-based Asia Plantation Capital (APC) acquired 260 acres of land in Malaysia for the planting of two agarwood plantations, and also opened a new agarwood processing factory and research centre, in Johor, Malaysia.[21] In addition, APC operates existing agarwood plantations in China, India, Sri Lanka, Myanmar and Thailand. The company aims to be the industry leader in the agarwood market. Those managing large-scale plantations argue that agarwood plantations are more sustainable than cutting wild *Aquilaria* trees.

***Will engineered microbes in fermentation tanks compete with newly planted Aquilaria plantations, or will they undermine investment in the plantation approach?***

## Synthetic Biology Production

In June 2014, a Swiss synthetic biology company, Evolva, announced that it is collaborating with the Malaysian Biotechnology Corporation and Universiti Malaysia Pahang to develop engineered yeast that can produce some of the aromatic compounds found in Agarwood. According to Evolva: "The goal is to create a new paradigm in the sustainable production of Malaysia's high value indigenous natural products, starting with agarwood fragrances."[22]

There is no timetable for commercialization. Evolva's 2014 annual report says the status of agarwood-related research is at the "pathway construction" stage.[23]

Efflorus is a Canadian synthetic biology start-up also working on producing oud oil. Efflorus believes their "bio-oud" will be on the market by 2017. They are also working towards other rare fragrances like Musk (source – Musk Deer) and Ambergris (source – sperm whales/clary sage).[24]

## Implications and the Future

Evolva makes a compelling case that biosynthesis of agarwood's aromatic compounds offers a more sustainable approach than illegal cutting of endangered trees. Given that wild *Aquilaria* trees are increasingly rare, will synthetic biology enable Malaysia to create a sustainable market and save the forest?

Will the aroma compounds produced by engineered microbes in fermentation tanks be able to compete with newly planted *Aquilaria* plantations, or will they undermine investment in the plantation approach? Evolva's website states that the company's syn bio platform will allow Malaysia to "widen the use of agarwood worldwide" and "complement the existing traditional production approaches."[25] It remains to be seen if Efflorus or Evolva and its partners can produce a commercially viable product via biosynthesis, and how that might affect the global market.

There is not yet a meaningful discussion about the impact that the transition from wild harvesting and plantation production to synthetic production may have on traditional collectors or plantation workers. Similarly, there is cause for concern that a shift from plantation production to synthetic production could negatively affect plantation workers.

## Endnotes

1 www.asiaplantationcapital.com/products/agarwood

2 Nineteen agarwood-producing species have been reported. Source: R. Naef, "The volatile and semi-volatileconstituents of agarwood, the infected heartwood of *Aquilaria* species: A review," *Flavour and Fragrance Journal,* 26, 73–89 (2011). regula-naef@bluewin.ch Natural forests in all three regions of Malaysia (Peninsular Malaysia, Sabah and Sarawak) remain important sources of agarwood in international trade.

3 The aromatic resin is produced naturally by Agarwood trees as a defense/healing mechanism when they are attacked by infection or pests.

4 Michael Zviely, and Ming Li, "Sesquiterpenoids: The Holy Fragrance Ingredients," *Perfumer & Flavorist,* Vol. 38, June 2013.

5 Including India, Myanmar , Laos, Vietnam and Cambodia to Malaysia, Sumatra, Borneo, the Philippines and Papua-New Guinea.

6 Malaysia made up about 50% of the total reported volume of agarwood declared in CITES trade internationally in 2005.

7 Studies have shown that even though many Orang Asli communities no longer collect as much gaharu (or agarwood oil) as they did 10 years ago (C. Nicholas, pers. comm. September 2005), prohibition on unlicensed collection and enforcement of the required licensing would have a significant effect on the income of certain groups, possibly exacerbating poverty.

8 Dr. Pakamas Chetpattananondh, "Overview Of The Agarwood Oil Industry, International Federation of Essential Oils and Aroma Trades (IFEAT)," *Proceedings of the IFEAT International Conference 2012.* www.ifeat.org/wp-content/uploads/2013/02/Singapore_Proceedings_lowres.pdf

9 *Ibid*.

10 Source: www.ifraorg.org/en-us/sustainability/article/45#.VTps67rrNO4

11 R Naef, "The volatile and semi-volatile constituents of agarwood, the infected heartwood of *Aquilaria* species: A review," *Flavour and Fragrance Journal,* 26, 73–89 (2011).

12 According to Asia Plantation Capital, the trade figures are from TradeMap.org www.asiaplantationcapital.com/products/agarwood

13 Md. Joynal Abdin, "The Bangladeshi Agarwood Industry: Development Barriers and a Potential Way Forward," Bangladesh Development Research Working Paper Series (BDRWPS 22) June 2014. www.researchgate.net/profile/Md_Joynal_Abdin/publication/263468435_The_Bangladeshi_Agarwood_Industry_Development_Barriers_and_a_Potential_Way_Forward/links/0c96053afdbccc8ea0000000.pdf

14 According to Asia Plantation Capital, the trade figures are from TradeMap.org www.asiaplantationcapital.com/products/agarwood

15 Lim Teck Wyn and Noorainie Awang Anak (2010). "Wood for trees: A review of the agarwood (gaharu) trade in Malaysia." TRAFFIC Southeast Asia.

16 *Ibid*.

17 Under Appendix II of CITES, agarwood trade is regulated under a system of permits based on conditions of legality and sustainability – but regulations are not implemented or enforced in all areas.

18 The Forest Research Institute Malaysia (FRIM) has long recommended the establishment of commercial *Aquilaria* plantations as a more sustainable solution for agarwood production.

19 Beginning in the late 1990s, for example, FRIM collaborated with a New Zealand research company, Industrial Research Limited.

20 In 2005 Malaysia planted agarwood trees on 40 ha of land in Mercang. Rosli Zakaria, "Agarwood's value is also its curse," *New Strait Times Online,* 4 November 2014. www.nst.com.my/node/49379

21 www.asiaplantationcapital.com/plantations/malaysia

22 Evolva News Release. "Malaysian Biotechnology Corporation, Universiti Malaysia Pahang and Evolva collaborate to establish centre of excellence for Malaysian Natural Products," June 4, 2014. www.evolva.com/media/press-releases/2014/6/4/malaysian-biotechnology-corporation-universitimalaysia-pahang-and

23 Evolva 2014 Annual Report. Reinach, Switzerland, 30 March 2015. www.evolva.com/sites/default/files/attachments/evolva-ar14-en.pdf

24 https://eu.indiebio.co/efflorus-luxury-fragrances-for-a-sustainable-planet/

25 Evolva News Release. "Malaysian Biotechnology Corporation, Universiti Malaysia Pahang and Evolva collaborate to establish centre of excellence for Malaysian Natural Products," June 4, 2014. www.evolva.com/media/press-releases/2014/6/4/malaysian-biotechnology-corporation-universitimalaysia-pahang-and