# VALUABLE FOREST PRODUCTS FOR INCOME GENERATING (SUCH AS GAHARU / ALOESWOOD)

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**This paper was presented on:**
**Training workshop on Rehabilitation of Tropical Forest NGO member in Lombok**

**Conducted by:**
**Dinas Kehutanan Propinsi NTB and JIPRO Japan**

**On 9-15 Desember 2008**
**in Lombok Garden Hotel, Mataram Lombok NTB**

**MATARAM**
**2008**

# VALUABLE FOREST PRODUCTS FOR INCOME GENERATING (SUCH AS GAHARU / ALOESWOOD)[1]

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Gaharu existence in the nature increasingly decreases; its production drastically decreases, whereas its price increasingly rises because world's need of gaharu growingly increases as the opening of global market and economical development at East countries such as Hong Kong, Korea, China, Taiwan and Japan, beside demands from Middle-East countries. To anticipate world's gaharu demand increase, Indonesia in general and West Nusa Tenggara in particular can not only rely on natural production. Indonesian natural gaharu production for AB class is only yielded from forests of Papua, Celebes and little from Borneo, even natural gaharu production at West Nusa Tenggara only yields dhum (*kamedangan*) class, whereas agarwood class can not be found again.

Gaharu tree is a local superior tree that has high economic value and has opportunity to be business good both as diversifying plant in the garden and rehabilitating and conserving local forest because such plant capable to meet requirement of conserving and rehabilitating plant viewed from plant characteristic, plant type, non wood (agarwood) forest production, can be harvest without cutting its wood, has multiple benefits, has high economical value, agarwood production can be increased by managing its cultivation and inoculation. Gaharu is one good example as a valuable forest products for income generation.

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## Characteristic of Plant

Gaharu is included as evergreen plant. Its canopy is exotic, conical, has clump to tree figure. Leaf shape is various from oval to spherical. Secondary leaf spine is curve for Aquilaria genus and parallel for Gyrinops genus. Commonly it grows in primary or secondary forest. This plant lives better when it is shaded by other plant. This condition will help germination of seed falling in the forest floor that is still dense and also its gubal formation.

## Species of Gaharu Tree

Gaharu is wood that comes from several species of Thymalaeaceae family, has aromatic resin content because such wood is infected by fungus, indicated by black or brown-black colour, and when fired it will excrete fragrant aroma and oil (SNI Bidang Kehutanan, 2000; Daijo & Oller, 2001). Based on form and aromatic resin content, gaharu is divided into three groups: 1) *agarwood* or *agar-battis* or *gubal gaharu* or *black-agar* or *true-agar* or *bantang* (wood piece whose cells is filled with aromatic resin, thus has black or brown-black colour); 2) *dhum* or *kamedandangan* (little aromatic resin content and less fragrant aroma); 3) *dust* or *abu* or *debu* (gaharu wood powder yielded from process of grinding or shattering gaharu remainder) (SNI Bidang Kehutanan, 2000; Chaudhari, 1993).

Gaharu tree that produces agarwood consists of various species that are generally included in Thymelaeaceae family. For example is species of Aquilaria, Gyrinops, Wikstroemia, Gynostylus Aetoxylon genus. However species producing gaharu that is preferred by consumers from Thymelaeceae family are only Aquilaria and Gyrinops genus (Hou, 1960).

Every gaharu species has different distribution and ecological area. For example, for Aquilaria genus such as *A. beccariana* van Tiegh. grows at swampland; this plant has distribution area from Sumatera and Borneo islands; *A. malacensis* Lamk. grows between rubber trees, found in India, Indo-China,

Bhutan, Myanmar, Bangladesh, Malaysia, Sumatra, Borneo and Philippine etc. (Hou, 1960 and 1964). For Gyrinops genus e.g. *G. versteegii* (Gilg) Domke. grows well between *Ficus* spp., *Calophylum* spp., and *Eugenia aquea* and *Arenga pinnata* or sugar palm trees; This species spreads starting from West Nusa Tenggara, East Nusa Tenggara, Minahasa to West Papua; In other place of West Papua, there is other gaharu species such as *G. ledermannii* Domke that grows between *Agathis* sp. and *Phodocarpus* sp. etc. (Hou, 1960; Zich & Compton, 2001).

Gaharu tree cultivated will has better growth if the gaharu species is the one that grows at such area (natural distribution area) when compared with introduced gaharu species.

Gaharu species in the world begin to be endangered, this is because its agarwood productions only rely on gaharu trees in the forest whose agarwood formation is natural. As increase of both domestic and foreign market demand, gaharu trees cutting in the forest also increase. Consequently, plant existence in the forest is increasingly scarce, even endangered to be extinct (Parman and Mulyaningsih, 1996).

Consequence of such above production sistem is that it is increasingly difficult to obtain agarwood because of the scarcity of gaharu trees that naturally produce agarwood in the forest. Then agarwood production tends to decrease, so as the export volume decrease. Related to the extinction of gaharu tree in the forest, IX CITES meeting in Florida at Nopember 1994 has decided that gaharu tree (*A. malacensis*) is included in the list of Appendix II or endangered to be extinct tree (Afifi, 1995; Wiriadinata, 1995). Even since January 2008, from yields of XIII CITES meeting in Bangkok at 2-14 October, 2004, gaharu species of Aquilaria, Gynostylus and Gyrinops genus are included in the list of Appendix II (Anonymous, 2006).

**Non-wood Forest Products**

This tree is inclued in class V wood that is used by people for board; specially for ramin wood (*Gonystylus* spp.), it can be used for furniture; *G.*

*decipience* wood can be used to make frame exported to Japan. Gaharu wood has creamy white colour, soft, light, and has rough texture, easy to be manually sawed, but will yield rough surface, and the sawing machine will be rapidly blunt. Normal wood has creamy white colour, soft and light with rough texture. The wood is easy to be manually sawed with very rough and fibrous yield because this wood contains a lot of fibers (schlerenchyme fibers). When the wood is drilled or sawed by sawing machine, it will cause the machine to be easily burned and worn-out because it has a lot of fibers (Mulyaningsih & Sumarjan, 2002).

Gaharu trees as one of valuable forest products for income generation because all parts of gaharu tree have benefits. For example its bark contains a lot of fibers and very strong; it is used by gaharu hunter as labelling tool to differentiate between gaharu tree and other tree, and can be used as materials of paper, woven cloth, book cover, ropes, bags etc. Its fruit can be used by local people as malaria medicine, and its leaves can be used as green tea, its wood that has no gubal can be used to chase the mosquito out (Mulyaningsih & Parman, 2002).

Main product of gaharu tree is agarwood that has specific aroma, which has been long traded as elite comodity for perfume and rosary industries, to burn corpse by Hindu community, as cosmetics, hio (joss stick), incense and medicines (Raintree, 2001; WCMC, 2001; Metcalfe & Chalk, 1923), to chase louse and flea out; can be made as beverage for stimulant, rheumatic, gout, paralyzed, diarrhea and nausea medicines (Metcalfe, 1934).

Gaharu oil is made from kemedangan (light brown gaharu wood, contains few aromatic resin). Oil of *G. versteegii* species is used by Lombok people for stimulant medicine, as lysine and aphrodisiac, as asthma and bronchitis medicines, etc. Destillating residue water is used as face smoothing and whitening, as well as genital washing for women. Whereas the waste is used as main material of incense (room and hair perfumes, hair louse chasing out), hio and anti-mosquito material.

Chemical compound content of garwood from *G. verstegii* species has not been definitely known, but there are approximately 8 compounds; its bitter fruit is

often used by local (Lombok) people as malaria medicine, and the tough bark is used as rope, woven cloth and bag materials (Mulyaningsih et al., 2005b).

Phytochemical content of gaharu is not less than 17 compounds: 3,4-Dihydroxy-Dihydroagarofuran, 4-Hydroxydihydroagarofuran, Agarol, Agarospirol, Alpha-agarofuran, Aquillochin, Benzylacetone, Beta-agarofuran, Dihydroagarofuran, Dihydroxyagarofuran, Gmelofuran, Liriodenine, Norketoagaraofuran, Noroxoagarofuran, Oxo-not-agarofuran, P-mehtoxybenzylacetone, P-methoxycinnamic-acid (WCMC, 2001). Tamuli et al. (2005) and Bhuiyan et al. (2008) suggest that natural gaharu contains compounds of: 7-Isopropenyl-4a-methyl-1-Methylenedecahydronaphthalene, Cycloheptane, 4-methylene-1-methyl-2-(-2-methyl-1-propen-1-yl)-1-vinyl-, Caryophyllene oxide, Octanic acid and 10-epi-γ-eudesmol; the last two compounds are also found in gaharu of inoculation product; beside those, it is also found diisooctyl phthalate, 1H-Cycloprop[e]azulen-4-ol, decahydro-1,1,4,7-tetramethyl-, [1ar-(1a.alpha., 4.beta., 4a.beta., 7.alpha, 7a.beta., 7b.alpha.)]-(9.16%), hexadecanoic Acid, naphthalene, 1,2,3,5,6,7,8,8a-octahydro-1,8a-dimethyl-7-(-methylethenyl)-, [1R-(1 alpha, 7 beta, 8a.alpa.)]-, and aristolene. In A.crassna and A.sinensis of inoculation types, it is found three compounds of diepoxy tetrahydrochromone: 7,8-diepoxy-2-(2-phenylethyl)-5,6,7,8-tetrahydrochromone, 7,8-diepoxy-2[2-(3-hydroxy-4-methoxyphenyl)ethyl]-5,6,7,8-tetrahydrochromone (Yogura, et al., 2005).

Agarwood of *A. malaccensis* Lamk. is known by Chinese, European and Indian since long ago, and according to ethnobotanical research, this gaharu species is used in China as stomach-ache, aphrodisiac, Anodyne, asthma, thyroid cancer, pulmonary tumor, cholic, diarrhea, kidney, and tonic medicines; in Europe, gubal gaharu is used as cancer medicine; in India, it is used as intestinal tumor medicine (Raintree, 2001; Gunasekera et al., 1981).

*A. agallocha* Roxb., which grows in India, China and Tibet, is commonly referred to aloeswood or agarwood. Traditionally, gaharu bark, root and gubal are used by local people as traditional medicine to treat inflammation, arthritis, nausea, heart disease, cough, asthma, anorexia, headache and gout. According to

recent research conducted by Miniyar et al. (2008), antioxydant activity of ethyl acetate of *A. agallocha* extract (EAA) may restrict nitrite effect and increase haemoglobin oxydation (increase methamoglobin formation) in human blood hemolysate. Antioxydant effect of EAA is strong at dosage of 500-3500 µg/ml.

Beside for main material of medicines, agarwood is used by Arabic countries for body and room sauna by fuming entile body/ room using smoke leaving agarwood or incense ember; this sauna function is as body perfume as well as blood flow girder and relaxing nerves. In Japan, gaharu is used to make traditional camphor and kissing tradition of various aromas; in Hong Kong, Taiwan and Korea as well as China, kamedangan is used to make hio. Hio and incense is usually made of lower class gaharu such as gaharu ash or kamedangan that is distillated previously to extract its oil. Gaharu oil is used as perfume or main material of medicine, whereas the distillation water waste is used for women genital washing or spa that can function for smoothing and whitening skin, as well as for intimate essence. In India, agarwood is used for rosary and corpse burning (Mulyaningsih et al., 2004b).

Agarwood (aromatic resin) is derived from wood or part of wood producing gaharu that naturally grow and has been dead as result of natural and artifial infection processes, and they are usually from several species of Thymelaeceae (SNI Bidang Kehutanan, 2000; Daijo & Oller, 2001).

Gaharu wood that is not infected by an appripriate microbes will not yield agarwood. In the forest, it is often found gaharu wood that has been old, up to 40-150 m in diameter, but it has not been able to produce agarwood. It ilustrates that in order to form agarwood, it needs microbes that enters through injury so that it can trigger gubal gaharu formation (Mulyaningsih, et al., 2005a).

Availability of gaharu seed in Indonesia is still very minimum because there is few gaharu seed businessmen in several islands of Indonesia, even there has no people that try to seed gaharu in large number to meet market demand. It is reflected by increasingly demand of gaharu seed from other island than Lombok, which is not less than hundreds thousand seeds every year delivered to various islands such as Sumbawa, Bali, Java, Celebes, etc.

## Has High Economical Value

Gaharu has specific aroma, therefore it is used for perfume, soap, incense, cosmetics, room or cupboard sauna (Heyne, 1950; Kanwil. Dephut, NTB, 1995); hence, it is commodity that has high economical value; market price in Irian forest is ranged from Rp 300,000 – 900,000,- per kilogram, depending on its class, and the price will be 10-10 folds when it has been at Jakarta, that is ranged from Rp 500,000 – 10,000,000,- (Clear, 2000).

In 1993, Indonesia exported 300 tons gaharu to Hong Kong, Japan, Taiwan, Singapore, Saudi Arabia, United Arab Emirate, Oman and Yaman with price of Rp 1,000,000,-/ kg for lower quality, even for superior quality the price will achieve US$ 10,000,000/ kg, particularly in United Arab Emirate, Saudi Arabia and Bahrain countries (WCMC, 2001).

In 2005, first class gaharu had been difficult to be found from forest, both in Borneo and Papua (Merauke, Agats, Mappi and Biak). Even in Agats and Mappi, gaharu is obtained by digging root remainders of cutting conducted in 1996-2000. Such root remainders are in swamp between sago palm trees, therefore, to obtain them we must dig to 2 m depth and dive to take such gaharu. Thus, gaharu price growingly increases; at gatherer level, price of the superior class may reach Rp 17,500,000,-, first class Rp 12,000,000,- and second class Rp 8,000,000,- (private communication with gatherer from Borneo and Papua).

In 2006, price of AB class (below superior class) gaharu in Celebes at hunter level had reached Rp 8,000,000,-/ kg, whereas at exporter level in Surabaya, it had reached Rp 15,000,000,-, even in Japan, gubal gaharu from Indonesia may reach 5000 yen/ gram (private communication with several hunters in Celebes, Mr. Samson Wongso, an exporter from Surabaya and Prof. Emeritus, Dr. Yamada Isamu from Kyoto University, Japan, September 2006).

In 2007, market price of AB class (below superior class) agarwood in Kalimantan at hunter level reached Rp 15,000,000,-/ kg, whereas at exporter level in Kalimantan it reached US$2,600 (Rp 20,000,000,- - 26,000,000,-). For

superior, double superior and triple superior, the price reached US$ 5,000 (Rp 35,000,000,- - 50,000,000,-) (private communication with several hunters in South and East Borneo, Mr. Chandra, exporter from Tarakan of East Borneo).

## Planting Management

In order to sustain gaharu wood as germ plasm source and increase agarwood production and export volume sustainably, it is needed penetration by replanting gaharu wood at forest area, cultivation at farmer land as plantation business. To support this effort, there should be technical touch that includes plant cultivation and agarwood production aspects. This commodity has high economical value, therefore it is expected to significantly increase rural people income, not only for the farmer, but also the labours. This is because activities from cultivation to post-harvest processing, thus yielding ready-to-sell product, will need numerous labors.

Cultivation of gaharu tree needs to be conducted because of the increasingly scarcity of gaharu tree in the forest. If it is not conducted, slowly or immediately there will be extinction of gaharu germ plasma source. Cultivation can be conducted at dry land or farmer's dike beside at forest area and out of forest area. In West Nusa Tenggara, gaharu cultivation program of *G. verstegii* species had been performed simultaneously since 1998 by both people and governmental instances. To support such effort success, it needs technological touch of cultivation and agarwood formation aspects so that the production quality and quantity may increase well (Parman and Mulyaningsih, 1996).

Cultivation technology that will be outlined here is technology that is mostly based on result of the research conducted by Mataram University and pratical experience obtained up to this time (Mulyaningsih & Parman, 2002; Mulyaningsih, et.al., 2002). The other is sourced from several relevant referrences.

### 1. Seeding

Gaharu seed is obtained by with drawing gaharu young tree that usually grows around the main tree (common way performed by gaharu famers) or spreading the seed. In seeding through seed, there are several things to be noticed:

*a. Selection of parental tree*

Parental tree selected should be tree that has upright stem so that the seed produced is as good as it. Age of parental tree also influences percentage of germinating potential. Five years old parental tree (learn to bear fruit) will yield seed that has lower germinating potential than seed derived from 7 years old parental tree (Sunarto, 2004).

*b. Selection of fruit*

Ripe gaharu fruit has yellow or orange to bright red colour. For seeding purpose, the fruit selected should be physiologically ripe indicated by its fruit peel colour, that is, flawless yellow (for yellow fruit) or flawless orange to bright red (for orange to bright red fruit). Seed of immature fruit will only have very low germinating potential between 4-8%, although the seed has been has colour (Mulyaningsih, et al., 2002).

*c. Selection of seed*

Gaharu tree has very high sterility seed that reaches 60-70%. It is seen when we plant gaharu seed randomly without selection. Therefore, before seeding full seed, the seed that sink in the water is selected. This will increase germinating potential to 84%.

*d. Seed storage*

Gaharu seed is included in recalsitrant seed, that is, its viability will continuously decrease if it is stored, although seed innertia is maintained, even its viability will dissapppear if the seed is dry-stored. Gaharu seed can not be stored at refrigerator temperature, if stored in the cold stored, its germinating potential will drastically decrease up to 4%. (Mulyaningsih et al., 2002).

*e. Seedling*

Good seed is one derived from black and full seed (because not all seed is fully filled by seed chip). The seed should be grown in porus medium, therefore the drainage can be running well, such as river sand, sedimentary stone sand, or mix

of soil and sand. Requirement of gaharu seed germination that medium must be in moist condition, and must be placed in shaded area (very low light intensity).

**2. Planting**

Planting should be conducted at early rainy season so that planting success can be secured. Seed selected is 5-7 years old seed. Before planting, hole is prepared with size of ± 0.3 $m^3$ and space of 3m x 3m, depending on existing field and plant conditions. Each hole is given fertilizer/ compost, then such fertilizer is mixed with original soil and planting hole is ready to use.

In planting of vast area, the time can be managed with consideration of harvesting time, every week, every month or every year. With periodic harvesting, the planting must also be conducted in rotation way scheduled according to planned harvesting.

In selecting area to grow gaharu tree, it must be recalled that gaharu tree has characteristics: it is included in tolerant tree, that is, it can grow well when planted at shaded area. Therefore the land should be planted with shading tree before planted with gaharu tree.

The tree will grow well if the area is high and has rainfall of more than 1000 ml/ year. This condition is equal with rainy month received, the more rainy month, the better gaharu tree growth. Area that has rainfall of less than 3 months, its growth is very slow. To solve water scarcity, spraying must be conducted. It can be conducted by drop irrigation. This can make water usage more efficient and good enough to increase gaharu growth. Gaharu tree can grow at height of 0-1200 m above sea surface, above this the gaharu growth will be inhibited or dead.

## Inoculation Way

Agarwood is derived from wood or part of wood producing gaharu that naturally grow and die due to natural or artificial infection process of such wood and generally occur in some species of Thymelaeaceae family (SNI Bidang Kehutanan, 2000, Daijo & Oller, 2001).

Gaharu tree can produce agarwood only when it is infected by fungi causing gubal formation. In nature, this fungi make infection through wound due to branch that is break or fall out. This fungi infection in nature is conducted through wind, rainfall splash or insect that bring such fungi. Infection occurs when air humidity is high or there is water wetting wound so that the spore can grow. Thus, infection onset occurs at rainy season, when the stem surface is always wet and air humidity is high (Parman, et al., 1998).

Microbes causing gaharu formation of each gaharu tree species are different; even it has been suggested that microbes at stem and root are different. Jalaludin (1977) reports existence of *Cytosphaera mangiferae* fungi as isolation result of gubal formed at *A. malaccensis* Lamk. gaharu stem, whereas according to Daijo & Oller (2001) it is caused by parasite fungi of *Phialophora parasitica* spesies. Such fungi, beside infect alive stem, also infect dead stem pieces. At root part, Venkataramanan (1985) finds micoriza abuscular vesicular fungi in the gubal obtained from root of *A. malaccensis.* Research result of Sediyasa & Suharti (1987) find various fungi such as *Diplodia* sp., *Pythium* sp. and *Fusarium solani* that play role in gaharu resin formation. In contrast, Tunstall in Asam find *Aspergillus, Penicillum* and *Fusarium* fungi at sick gaharu tree. This research is continued by Bose in 1939-1941 by inoculationg such fungi to healthy gaharu tree and produce gaharu resin, although it is limited at 2 cm radius at part being inoculated (Beniwal, 1987). Beside that, research in India also found other fungi specieses in tissue containing aromatic resin, they are *Torula cylindrocephalum*, *Ganoderma lucidium* and *Epicoccum grnulosum*. Chaudhari (1993) suggests that gubal gaharu formation in such tree is caused by bacteria and fungi. Umboh, et.al. (1997-1998) use *F.oxysporum, F.solani, Scytallidium* sp, *Libertella* sp. and *Trichoderma* sp. to trigger gubal formation in *A. malaccensis* and *A. crassna*.

Included floem or interxylary floem in *G. verstegii* stem is spread in stele, one of its function is as food essence deliverer to entire wood tissues. In nature, agarwood formation begins from interxylary floem and then creeping to pith fingers, then filling trachea (xylem) part, then filling other cells parts (Mulyaningsih & Sumarjan, 2002; Itoh, et al., 2002).

According to Umboh, et.al. (1997-1997) and Mulyaningsih, et al (2005b), synergysm of several isolate fungi in *Aquilaria* sp. and *G. verstegii* trees may produce darker black gubal colour and lead to various aroma with different aroma degradation. This is because every isolate fungi has different ability to induce gubal formation and lead to specific aroma, beside that season also influences the quality of agarwood production (Mulyaningsih et al., 2005a).

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