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ORIGINAL ARTICLE

AGARWOOD PRODUCTION FOR INTENSIVE INCOME GENERATION

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Abstract:

Aquilaria malaccensis Lam. Syn. A. agallocha Roxb. (Thymelaeceae) is a resinous tree and commonlyknown as agar or sasi. The tree is distributed in South and South East Asia (Donovan and Puri, 2004), from the foothills of the Himalayas to the rainforests of Papua New Guinea (Agarwoods keralam, 2013).

KEYWORDS:

Intensive Income Generation , Agarwood , subtropical .

INTRODUCTION

In India, agar tree (*Aquilaria malaccensis*) is distributed in all the Northeastern States (Hajra, 2000). Agar tree is a natural component of the evergreen and semi-evergreen forest flora of the NE region. However, it is now rarely seen in such habitats because of over-harvesting and indiscriminate felling. It prefers a subtropical climate with high humidity and rainfall range of 1800-3500 mm. It requires a reasonable amount of sun and well drained soils but will grow in a plantation situation with some shade from other longer rotation species.

The tree

It is found in natural forests at an altitude of a few meters above sea level to about 1000 meters, however, it grows best around 500 meters.Agar tree is a medium size evergreen tree attaining a height of 15-40 meter and diameter of 0.6- 2.5 meters (Chakrabarty et al., 1994; Sumadiwangsa, 1997).The plant has a straight bole, but may become fluted (Fig. 1). The wood is soft, light, elastic and white to yellowish-white in colour. Leaves are oblong-lanceolate with undulating margin and up to 9 cm long. Flowering occurs during April-May and seeds mature in about three months. Multiplication of the plant is through seeds, which have a short viability period.

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Fig. 1. Agar plantation

Variation within species

In northeastern India, two types of *A. malaccensis* could be identified as *Jati Sanchi* and *Bhola Sanchi* in domesticated agar population. *Bhola Sanchi* is comparatively of quick growing but yield is lesser than that of *Jati Sanchi*, so *Jati Sanchi* is preferred for commercial cultivation (Saikia and Khan, 2012). Other agarwood producing species of Aquilaria are: *A. khasiana, A. sinensis, A. crassna, A. benccariana, A. cumingiana, A. microcarpa, A. hitra, A. ovata and A. filaria.* All the species are distributed in the South East Asian region.

Importance of products and their uses

Agarwood has been prized as incense from ancient times. It is traded in several forms, ranging from large sections of trunk to finished products such as incense and perfumes. Agarwood chips and flakes are the common traded forms.

The major constituents of agarwood oil are sesquiterpenes, the chemical structure of which makes them very difficult, hence extremely expensive, to synthesize. Although synthetic agarwood compounds are used to produce poor-quality fragrances and incense sticks, there are currently no synthetic substitutes for high grade incense or oil.

Agar oil and agaru or agarwood are the most exalted perfumery raw materials obtained from the infected wood of agar tree. The agar oil known in the East as agar-attar is one of the perfumery's oldest materials. It is considered one of the costliest perfumery raw materials used in high-class perfumery and fixative, imparting a lasting balsamic odour to the product and is much priced in international market for mixing it with quality perfumes.

The use of agarwood oil for perfumery extends back several thousand years. In India various grades of agarwood are distilled separately before blending to produce attar (scent). Minyak attar is a water-based perfume containing agarwood oil, which is traditionally used by Muslims to lace prayer clothes. Agarwood essences have recently been used as a fragrance in soaps and shampoos.

Agarwood has also been used for medicinal purposes for thousands of years, and continues to be used in Ayurvedic, Tibetan and traditional East Asian medicine. Agarwood and its products are described as aphrodisiac, alternative, anodyne, antidiarrhoeal, antiasthmatic, astringent, carminative, cordial, diuretic, laxative, stomachic and tonic andincorporated into the preparation of several pharmaceutical and cosmetic products.

Presently, market value and demand of first grade agarwood is extremely high. First grade agarwood is one of the most expensive natural raw materials in the world, with prices in consumer countries ranging from a few dollars per kilogram for very low quality material to more than US$ 30000 per kilogram for top quality wood. Agarwood oil fetches similarly high prices. (Agarwood "Wood of Gods" International Conference, 2003)

Agar oil is an export-oriented product and the demand is very high in the international market. The large gap in the demand/supply situation is due to the scarcity of raw materials, lack of favorable policy and schemes, and also due to lack of fuel wood required for kilns during extraction of oil. Production costs include raw materials, labour, fuel wood and other miscellaneous costs like rent, electricity etc.

Natural process of formation of agaru and agar oil

A specific fungus (identified to be *Phialophora parasitica*) is responsible for this physiological host-parasite interaction. Various symptoms of infected agar tree were recorded to identify the infected tree. Infestation of borer, *Zeuzera confetra* was observed on agar tree in different study sites. Fungal species viz., *Fusarium sp., Rhizopus sp., Aspergillus sp., Mucor sp., and Penicillium sp.*, were isolated from the infected host tissue. Natural infection occurs in the wood when

Fig. 2 Larva and pupa of Zeuzera confetra

trunks of standing trees are bored by a larvae of a stem borer mainly Zeuzera conferta walker (Nath and Saikia, 2002) (Fig. 2). It is seen that the larvae of *Z. conferta* bore the standing tree trunk of *A. agallocha* and make tunnels inside the tree trunks. Fungus enters the plant through this vertical

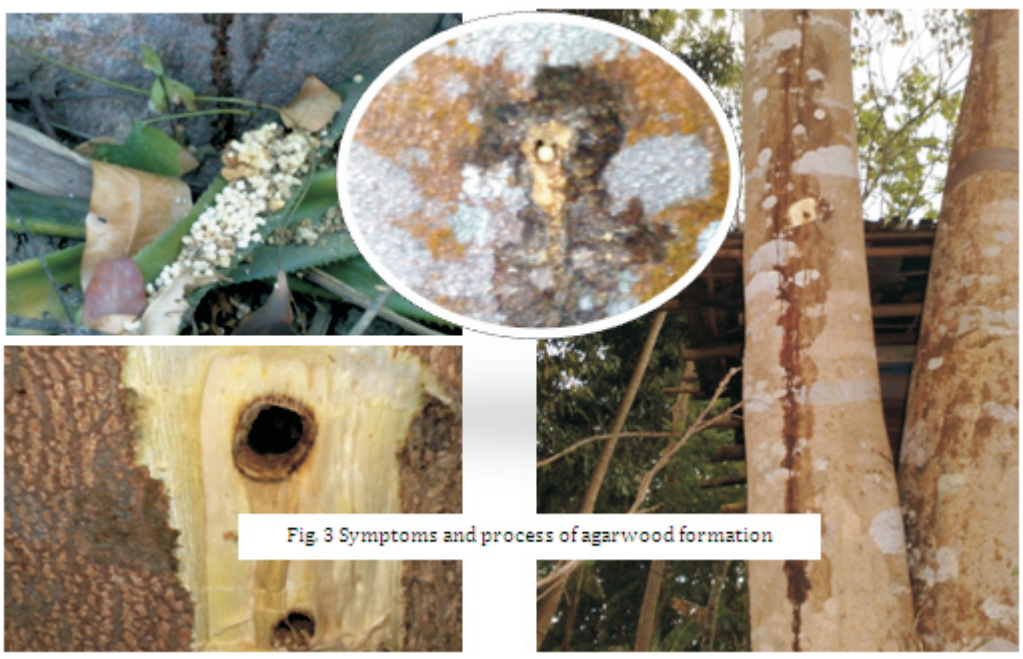

Fig. 3 Symptoms and process of agarwood formation

hollow sometimes –zigzag tunnel inside the stem, which serves for easy spread of infections. Year after year, infectionspread on all sides slowly and gradually and ultimately a large wood volume gets infected (Fig 3). Formation of agarwood is the revivification of accumulated oleoresin due to the action of microorganisms which continues for a period of 7-8 years after infection. At the initial stage infection appear as brown streaks in the tissue. Accumulation of oleoresins goes on increasing with the increase of infection rate as well as aging of infection. As more of oleoresins are deposited the intensity of colour of the infected wood increases and finally it becomes black and odoriferous due to increase in concentration (Fig. 4).

Fig. 4 Agarwood in different concentrations

Infection may also occur due to mechanical or natural injuries on the stem but the infection occurs in much localized portion only. Due to infection oleoresins are accumulated in the infected wood and later become odoriferous. For agaru formation the hollow tunneling inside the trunk/stem of the living tree seems to be necessary.

An appraisal conducted with the farming communities of the villages in Central Assam reveals that the agarwood formation takes much time to harvest and a 40 - 50 year old tree yields higher and approx. 2 – 5 kg of agar oil can be extracted per tree. The highly concentrated agarwood becomes heavier than water and this way can be categorized into different grades. Agarwood can be harvested at the age of 10-11 years of an agar tree if it gets infected at an early age of 5 – 6 years, but an infection free tree can't yield during its whole lifetime.

Artificial induction for agarwood formation

Artificial inoculation technique already developed and standardized in lab scale is found to be most effective and reliable method for enhancement of agar production. In 2005 the University of

Minnesota applied to have the patent in US. From reading their patent applications, the use of fungal treatment is not supported. Instead they claim that the insertion (through drill holes) of common salt (NaCl), ferrous chloride, sodium bisulfate and formic acid shows the best results. These chemicals are claimed to "disrupt the growth of cells around the wound and stimulate greater agarwood production".

Indicators for productive trees

Since agarwood is located deep within the trunk, its detection from outer appearance is not easy. Fungal infection usually takes some time to make it noticeable, and hence agaru is hardly found in young shrubs. Generally, such trees are distinguished by certain external features whether or not the tree harbors precious agar oil or agaru deposits. These include:

A poor crown, decayed branches, and uneven bole.
Swelling or depressions and cankers on the bole.
Appearance of hordes of ants in the fissures.
A distinctly yellowish to brownish tinge in the wood under the outer bark.
Sign of ill-health particularly die-back symptoms of the top and outer branches and yellow tint to the woody tissues.
The wounds, cankers on tree bole, stem distortions, smaller leaves, and distinctly yellowish tinge are visible when agarwood formation takes place.
A normal wood in a healthy treeappears as pale brown buff colour. Any change in color can be observed by removing the bark of the tree.
Sometimes screw augers are driven inside at various depth and samples are drawn for examination. Finally, the typical odour of these samples helps in confirmation for agarwood formation.

HARVESTING OF AGARWOOD

Harvesting time

Although the collection of agar trees for oil extraction as well as for agaru is done almost throughout the year, the best time is during February-May, the dry season when the plants remain almost dormant or less active. During this period maximum concentration of oil with less waxy substances is obtained. When stress is more bio-molecule concentration is also more. The extracted oil during dry season possesses the finest odour and note compared to that during rainy season when the plant remains active in growth.

Harvesting of trees to produce oil normally is not recommended before 10 years. The yield of resinous wood can vary greatly from tree to tree and is unpredictable. In additions agarwood from young (10 year old) trees is of low value when compared with the agarwood from 15- 20 years old trees.

Harvesting method

All agar trees do not form agarwood and is found invariably in some of the defective and diseased trees only. Only few skilled and experienced planters can identify agarwood bearing trees, and therefore, unskilled and ignorant laborers may fell these trees indiscriminately, endangering the very existence of the species. Hence, a farmer friendly standard technique of artificial infection need to be extended to induce on agar trees for an early agarwood formation, so that such indiscriminate felling can be checked.

After felling a tree, the leaves and smaller branches are removed. Then the tree cut into logs (pieces of 2 – 2. 5 feet). Thereafter, the logs are split to separate out the infected and non-infected woods. The physical age, growth rates and/or wood volume or physiological maturity do not govern the harvesting age of agar tree for commercial purpose. It is the infected tree and whose further growth is arrested due to physiological imbalance is harvested and yields agarwood and oil.

Generally, the bad and deformed trees can be harvested first unlike other forest species. The healthy trees are left to undergo stresses or subject to infection either naturally or artificially to induce oil formation. The harvesting is done on selection and continues for a longer period from a plantation raised at the same time.

Agar processing

Two types of commercial products are obtained from a harvested agar tree (a)agaru or agarwood

that is used as incense and(b)essential oil or agar oil or agar-attar. Agaru is obtained from older trees while oil is distilled from the old as well as younger trees.

Fig. 5 Process of obtaining agar oil (a) Agarwood as in tree (b) Agarwood chips (c) Chips as in cooking chamber (d) Distillation unit and (e) Agar oil after distillation

The agarwood of any grade if detected is first separated out with the help of indigenous tools like hacksaw blade and *Batali* (Chisel) and then graded based on the oleoresin impregnation, colour density, specific gravity and finally the colour. These are then dried, cleaned by removing the white woody portions as far as practicable, polished and graded for marketing.

To obtain agarwood oil, chips are soaked in water for 1 or 2 months, then steam "cooked" in steels from 15-40 days to extract oil. The quality of agarwood chips, cleaning of chips, water source/ quality, types of wood used for fuel and types of steels used are all regarded as important to product quality.

Agar oil is obtained by steam distillation of harvested wood chips or coarse powder in special type distillation Unit. Distillation is continued for 5-10 days or more using firewood or rice husk as the energy source.

Yield

The yield of commercial product of *agar* tree is not uniform in all productive trees. It varies greatly and is almost unpredictable. After 10 years of planting with intensive management each infected tree may yield about 30-40 kg of agarwood. Intensity and ageing of infection varies from tree to tree, and thus, recovery of oil also varies depending on type of raw material (agarwood chips) used for distillation.

Anticipated yield and income

Assuming 1500 surviving trees at 8th year out of the total 1600 per ha planted at 2.5m x 2.5m, the farmer can harvest about 40% of the selected trees i. e. 600 trees with a view to thin out the population for remaining 900 trees for further growth and development and also to generate an interim income.

The final harvesting (900 trees) would be done at 15th year.

Assumptions

Yield of Agarwood:

The agar products are extracted in four different forms in different stages of ageing and infection –

Boya – It is a fat extracted from an uninfected wood at an early age of the tree.Being available in cheaper rates, it has a demand in a different section of users.

Dum – It is the agarwood oil extracted from the lightly infectedwood, not by insects, but due to natural injuries and mostly obtained at the junctures of broken branches of young trees.

Kolagachi – It is the agarwood oil extracted from naturally infected wood by borer insects. This is the high quality oil in international trade.

Batali mal–It is a naturally infected wooden piece separated by using batali (an indigenous chisel). Such pieces are in demand for use as incense (dhoop).

1. Yield of wood for fat content (low quality Dum or Boya) from 8-10 years old tree approx. 20 kg./tree @Rs. 10.00/kg

2. Yield of *Dum* at 15th year=50 kg/tree @Rs. 50.00/kg

3. Yield of *Kalagachi*/Batali mal (agarwood) =0.5kg/tree@Rs. 2000/kg from about 500 trees.

Economic Return

Gross return

1. At 7-8th years *Dum* 600X20X10 ……..……Rs. 120000.00
2. At final harvest *Dum* 900X50X50 ……..……Rs. 2250000.00
3. Agarwood 500X0.5kg=500X2000 ……..… Rs. 1000000.00

Total Rs. 3370000.00

Net return

Total Income Rs. 3370000.00 – Expenditure Rs. 424000.00=Net Income Rs. 2946000.00
(Source: Handbook of Medicinal and Aromatic Plants – Agar Plantations 39-48pp. NEDFi Publication, http://assamagribusiness.nic.in/NEDFi/map11.pdf (accessed on Jan 10, 2014)

Yield of agaroil:

The facts and figures recorded for the past 25-30 years from the villages of Central Assamreveal that the oil recovery percent ranges in between 0.12 to 0.2 % which certainly depends upon the raw material grading in respect of intensity of infection.

From an established plantation thus a net income of Rs. 25-30 lakhs after 15 years may be generated giving an average of Rs. 196400.00/year/ha. Intercropping of other suitable crops in early stages of growth can generate extra income for at least initial 5 years.

Trade in agar products:

Agar is a non-timber forest product (NTFP) of immense commercial importance and originates in India and South Asia. These are widely traded as the most valuable item especially for high-class perfumery. Agar oil is now used in aromatherapy. There is a long history of utilization of agarwood in traditional system of meditation in China, Japan, India and several other countries. The bulk of the world's agar produce goes to the Middle-East market.

Aquilaria sp., were listed under Appendix II of the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES). The effect of this listing (that was requested by the Central Government of India) is that export of plant, plant portions, derivatives and extract are prohibited if obtained from the wild. A CITES permit for export is required for cultivated plantation grown agar, when it is accompanied by a Certificate of Cultivation. "This is obtained from Regional Deputy Director of Wildlife (CITES Management Authority), or the Chief Conservator of Forests or Divisional Forest Officers, in the state where material was procured".

The trade in agarwood and agar oil from an Indian perspective, centers on the middle east countries plus smaller quantities for the Indian domestic market for tourist sales to middle eastern tourists, domestic Ayurvedic medicines and incense sticks. The trade is closely managed, with highest value processing and exports being dominated by AJMAL Group in Hojai, Nagaon, Assam (probably contributing more than 95% of exports from India). Small quantities of agarwood oil are produced by small village based distilleries in rural areas of the NE, with their output being purchased by the AJMAL Group, or by Mumbai traders for tourist sales.

European agencies are now investing millions of dollars on R & D Works and commercial cultivation in several Southeast Asian countries. In contrast, Government of India could not do much in this sector. There is a scope for expanding organized cultivation of this immensely valuable commercial crop in the NE region and other non-conventional areas of the country with agro-climatic condition similar to the NE region. It is a good sign that several private agencies have come forward for large-scale cultivation of the trees in North Eastern India. Due to abundance of agar trees in Northeast, the trade of agarwood has become a fascinating industry in this area. Hojai, situated in Central Assam is the important trade Center for agar industry. Due to high return in trade, the trees are being promoted outside the forest areas also.

CONCLUSION:

The great potential already existing for organized cultivation of agar plants in the entire NE regions which provide an opportunity to produce agarwood and oil on a sustainable basis. However, there is an ample scope for improvement in the areas of agro-technology, quality planting material production, plantation management, enhancement of production through early inducement of agar oil and agarwood in cultivated trees.The traditional technology used for extraction of oil is an energy intensive process and adds significantly to the cost of oil production. Use of energy efficient distillation plant and alternative energy source in place of firewood for distillation of agar oil will not only reduce the cost of production but also reduce the negative impact and stress on the environment. R & D activities on this important tree crop are meager. There is immense scope for biotechnology too. Value addition of agar oil may be done through the use of microbes and microbial enzyme system.

Improvement of quality planting materials may be done through tissue culture technique. The need for a separate agar Research laboratory in the NE region is felt since a long time. Govt. initiative is necessary to streamline the strategies of agar trade especially for agar products collected from cultivated trees. Initiatives in this direction may ensure improving the economy of the region by givinghighest benefits to the farmers and agar oil distillers. Agarwood appears to be of medium profitability. However it involves a 15 years or longer waiting period to get the highest returns. It should however still be suitable for promotion as an IGA activity on household, private or forestry land in conjugations with other plantation species.

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