CHAPTER-1

INTRODUCTION
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Homegardens have a long tradition in many tropical countries. They consist of an assemblage of plants and include trees, shrubs, vines and herbaceous plants, growing in an adjacent to a homestead or home compound (Nair 1993). Homegardens represent a well-established traditional land-use system in Bangladesh and about eighty percent of the rural population live in villages having small gardens (Zashimuddin, 2004). Such gardens play an important role in the livelihoods of rural poor, and the rural economy of the country (Chowdhury and Mahat, 1993). Homegardens are sustainable source of food, vegetables and cash income for the rural people. Homegardens are playing significant role in the livelihood of rural people by providing subsistence needs, otherwise for which they will have to depend on forests.

Homegardens provide a large number of NTFPs which improve the lives of rural people and also play an important role in conservation of forests. The contributions of non-timber forest products have a positive impact on rural livelihoods. It is also widely believed that poor rural communities may be less inclined to engage in illegal logging if they are able to derive more material benefits from maintaining forests for various alternative goods and services (Oldfield 1988). Moreover, in many cases, development of non-timber forest resources has assisted stakeholders in obtaining opportunities to merge forest conservation with economic development at the community and national levels (CBD 2003).

Non-timber forest products and homegardens play crucial roles in the livelihoods of people living in most tropical countries. They also play important roles in forest conservation.

The genus *Aquilaria* (derived from the Lat. Aquila, the eagle) belonging to the family Thymelaeeae consists of about 500 species, mostly distributed in South-east Asia, Tropical Africa and Australia (Beniwal, 1989). The genus *Aquilaria* occurs in northeastern region of India, Nepal, Bhutan, Burma and extends through South-east Asia to
Philippines. There are about 15 species of this genus *Aquilaria* and only two species occurs in India. (Beniwal, 1989) *Aquilaria malaccensis* and *Aquilaria khasiana* have been reported to grow naturally in the plains, foot-hills of North-East India. (Hajra 2000)

**Distribution & Habitat:** *Aquilaria malaccensis* occurs in India, Bhutan, Malaysia, Philippines, Indonesia, Bangladesh, Myanmar, Singapore and Thailand. In Assam, it occurs in the districts of Sibsagar, Sadiya, Nagaon, Darrang, Goalpara and Cachar (Atal and Kapoor, 1982). Approximately, 15-20 agarwood producing species are well distributed in south and south-east Asia to the Pacific (Barden et al., 2000, Donovan and Puri 2004, Thawatachai 2007). Like other tropical tree species they can be found in single dominant stands, but are predominantly scattered throughout the habitat (Barden et al., 2000). Nevertheless there is a need for more research regarding the distribution pattern in most countries to understand the magnitude of its limits and occurrences. In Assam, two types of *Aquilaria malaccensis* could be identified as “Jati Sanchi” and “Bhola Sanchi” in the population. It is distributed along the foothills in the evergreen and semi-evergreen forests of Arunachal Pradesh, Assam, West Bengal, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura (Beniwal, 1989). In Konyak homegardens of Nagaland, Konyak Nagas successfully domesticate *Aquilaria agallocha* (Ramakrishnan et al., 1996). It grows on sandy clay soil. *Aquilaria* species have adapted to live in various habitats, including those that are rocky, sandy or calcareous, well-drained slopes and ridges and land near swamps (Barden et al., 2000). They grow between altitude of 0-850m, in location with average daily temp. 20-22°C (Keller and Sidiyasa, 1994; Wiriadinata, 1995). The genera is well adapted to various natural habitats from lowland rainforest to montane forests at an altitude of 800-1500m asl (Thawatachai, 2007).

**Botanical description:** *A. malaccensis* can grow upto 20-40 m tall and 60 cm in diameter. Ding Hou (1960) records *A. malaccensis* as a tree that grows upto 40m in height with a 60 cm diameter trunk. Young bark is light-brown with fine-hairs, older bark is smooth and whitish in colour. Leaves alternate, elliptic or lanceolate, 3-3.5 cm
wide and 6-8 cm long (PROSEA 2005). Inflorescence terminal or axillary. Flowers upto 5 mm long, fragrant and white in colour.

Fruit:- Fruits are green, egg-shaped capsule, leathery exocarp with fine hairs, 4 cm long and 2.5 cm wide. There are two seeds per fruit. (PROSEA 2005).

Seeds:- Ovoid, blackish-brown and densely covered with red-brown hair. There are about 1500 seeds per kg.

Flowering and Fruiting habit:- The tree starts flowering and fruiting at the age of 5-6 years and medium sized trees are reported to produce about 1.5 kg of seeds during good seed year. In Sumatra, flowering and fruiting season is twice a year. In our area, flowering was found in the month of April-May and fruiting found in the month of May-June and is once a year.

Medicinal uses:- *Aquilaria malaccensis* is used in gout and rheumatism. It has carminative and stimulant properties and is also used in bronchitis and headache) Kumar, 2002). Ayurveda recommends Agar in vitiated conditions of Vata and Kapha, dyspepsia, anorexia, cardiac debility, skin disease, leprosy, foul ulcers, inflammations, arthritis, cough, asthma. External application of Agar is useful in vomiting in children and pneumonia. The oil advised in cough, arthritis, cough, asthma, bronchitis, leprosy, skin diseases and foul ulcers.

Homegardens are traditional agroforestry systems characterized by the complexity of their structure and multiple functions. Homegardens can be defined as “land use systems involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably livestock within the compound of individual, the whole tree-crop animal unit being intensively managed by family labour. (Das and Das, 2005) (Fernandes and Nair, 1986). The homegardens appear to be a haphazard mixture of trees, shrubs and trees.
Agarwood is classified as a non-wood forest product primarily from species in the genus *Aquilaria* (Thymelaeaceae). Agarwood is defined in this review as the fragrant resin produced in all species from the genus *Aquilaria* and *Gyrinops*. (Anton Lata 2007) Agarwood provides distinctive ingredients in medicinal, aromatic and religious ceremonies and rituals in many East Asian and Arab countries. (Chaudhari 1993, Barden *et al.* 2000, Than 2007). Agarwood is traded under various names (gaharu, agarwood, aloeswood, eaglewood) and is used for incense, (Qi and He 2005, Gianno and Kochummen 1981), perfumes (Chaudhari 1993), medicines, aromatherapy (Barden *et al.*2000, La Frankie 1994), and religious ceremonies (Qi and He 2005, La Frankie 1994). Agarwood is highly valued by consumers in Asia and Middle-East, including countries such as Saudi Arabia, the United Arab Emirates, Hong Kong, Japan and Taiwan for its distinctive fragrance. Indonesia and Malaysia were the leading exporter of agarwood from 1995-1997 with Singapore the main re-exporter in the same year (Barden *et al.* 2000).

Aromatic plants yielding essential oils have multifarious uses from time immemorial like aroma therapy, pharmaceutical preparations, cosmetic and perfumery. Their sustainable exploitation is essential to meet the challenges of the 21st century for economic development of the society, biodiversity and environmental conservation.

Agarwood is solid in the the form of woodchips, woodpiece, powder dust, oil, incense ingredients and perfumes for several thousand US dollars per kilogram (La Frankie 1994, Barden *et al.* 2002 Gunn *et al.* 2004, Compton 2007). With such a high economic value, the rate of agarwood exploitation from natural populations has increased to meet the demand. This has resulted in the degradation of wild sources of *Aquilaria* in South-East Asian countries (Barden *et al.*2000) including West Papua New Guinea (PNG) (Jensen 2007).

A member of the family Thymelaeaceae, *Aquilaria* is a relatively slow-growing, medium-sized tree, on average 15-25m tall, some of the more than 15 species (e.g. *A. microcarpa*) reach height of as much as 40m. Most *Aquilaria* species have smooth,
thin, pale gray bark with dense, dark foliage of shiny elliptical to oblong leaves (7.5-12 cm long by 2.5-5.5 cm wide) (Ding Hou, 1960). *Aquilaria* regenerates freely under natural conditions as seedlings around the mother tree or sprouts from the stumps of harvested trees. However, mother trees are becoming scarce in many areas because of over-exploitation (Beniwal 1989, Paoli et al. 1994, Hasnida et al. 2001, Soehartono and Newton 2002, Quan et al. 2003).

Observed from the present study that the leafing pattern is periodic growth, semi-evergreen type. Leaf fall starts in the month of January and continue up to April. New leaves start appearing in the month of February and lasts for three months. Flower bud started appearing during the second week of April and last up to the end of May. Fruits are seen in the middle of May and ends in the end of June. Seed germination started in the first of June and lasts up to second week of July.

The fragrant wood of this tree is burnt as incense in the temple and the tree bark used to make Joss-stick, “Agar attar” is very good perfume retainer and is blended with high grade perfumes. It is used in India as drug or perfume.

The wood infected by certain fungi, develops large and irregular patches of dark streaks charged with oleoresin and becomes odiferous. The intensity of the dark patches of agar is a measure of the quantity of oleoresin present. Agar is found frequently in trees that are 20 years old; but commercially exploitable amounts of agar are found in 50 years old trees. Trees 80 years old are known to be riches in their content of agarwood, varying from 6.9 kg to 9.0 kg per tree. Agar is the pathological product of a fungal disease contracted by the tree chiefly through wounds on the trunk – Since agar is located deep within the trunk, its detection is not easy. Generally such trees are distinguished by poor crown development, the presence of swellings or depressions or cankers on the bole (Agarwood. White Lotus Aromatic Newsletter).

A shade-tolerant tree, *Aquilaria* is an understory tree of mature evergreen and semi-evergreen forest occurring at low to medium altitude, generally up to 1000m asl
depending on the species. The occurrence of the tree itself does not guarantee the presence of the resin. Scientists estimate that only 10% of the Aquilaria trees in the forest may contain gaharu (Gibson, 1977). The resin forms in response to wounding and subsequent fungal infection, and is found in many parts of the tree, according to some sources in the bark and the roots as well as the heartwood (Jalaluddin 1977). In some of the earlier exploited areas several species are thought to be extremely rare, if not extinct in the wild, for example, in Bangladesh and Java (Chakrabarty et al. 1994).

As with many NTFPs, gaharu has a history of boom and bust markets (Gianno 1990). Malaysia and Indonesia, however, appear to be the world’s major exporter of the product, which trades in the form of wood chunks, chips and dust as well as processed goods such as essential oil, perfumes, incense and medicinal preparation (Chung and Purwaningsih 1999, Barden et al. 2000). Unconfirmed reports indicate that synthetic eaglewood oil is for sale in Bangkok at a twentieth of the price of the genuine oil. The sophistication of the consumer and the preference revealed for natural products in the herbal medicine market in general would suggest that the demand for naturally produced resinous wood and its product will endure (Donovon, 1999).

Overexploitation of agarwood:- Excessive exploitation of natural sources of agarwood has been reported in Laos People Democratic Republic (Jensen 2007), China (Wang 2007), Myanmar (Than 2007) and Indonesia (Newton and Soehartono 2001). In Malaysia, A. malaccensis, the main agarwood producing species is classified as endangered resulting from overexploitation of its natural populations for the international trade (Ibrahim et al. 2007). The depletion of agarwood in India was reported as early as 1907 with no significant amount of agarwood available. In response to this, agarwood plantations were established in India in 1930’s and 1940’s, primarily by private growers across Assam (Quavi 2007). Indonesia was a major exporter of high quality agarwood (A. malaccensis) but there is little knowledge on the extent and status of remnant wild stands (Soehartono, 2003).
Valued mainly for its aromatic, fumigatory and medicinal properties, gaharu is the fragrant, resin-impregnated wood found in approximately 17 species of sub canopy trees of the genus *Aquilaria* (Thymelaeaceae) commonly found in mixed heartwood hill forests across tropical South-East Asia (Chung and Purwaningsih, 1999). The degree to which the resin saturates the heartwood phloem fibers determines the market value of this product. In lesser quality specimens, the resin creates a mottled or speckled appearance in the naturally pale wood, but higher quality specimens are nearly solid in color- glossy and black (Donovon and Puri, 2004). The species that produce high quality resin include *A. agallocha*, *A. crassna*, *A. bailloni*, and *A. grandiflora* (Burkill, 1966; Soehartono 1997).

Declining supplies of natural NWFP stocks will create strong incentives for domestication & cultivation of NWFP species on degraded forest land & in agro forestry system (Iqbal 1993).

Conservation through domestication can be made successful by increasing the value of wild resources to local communities. Although tree species display many characteristics that increase their potential for sustainable use, the approach is rarely successful in practice. Case studies illustrates that trade in forest products often provides insufficient financial return to protect the forest against threat.

The degradation of natural agarwood sources has led to an irregular product supply and quality. The cultivation of agarwood can potentially (1) increase the supply for trade (2) provide a sustainable income source for the local producers (3) reduce the pressure on natural habitats (4) conserve the species outside its original habitat and (5) help in environmental conservation. To reduce the pressure on natural populations, attempt has been made to cultivate the species in the homegardens of the local people inhabiting nearby forest areas. In order for *A. malaccensis* to be managed sustainably, information is required on the growth and survival of the species in response to different environmental factors (Soehartono and Newton, 2000)
Conservation status:- 2010 is the international year of Bioviversity yet habitat destruction, over-exploitation and pollution continue to contribute daily to the rapid loss of species. Populations of eight *Aquilaria* species have already declined to the point where they are considered threatened according to IUCN Red List Categories (Oldfield et al. 1998). A report by Chakrabarty et al. (1994) documenting India’s trade in agarwood concluded that *A. malaccensis* is highly threatened in that country due to over-exploitation of the species for commercial purposes.

Seven other *Aquilaria* species are also considered threatened according to IUCN Red List Categories, five of which are considered to be at risk from over-exploitation for agarwood. *A. beccariana* (vulnerable); *A. crassna* (critically endangered); *A. cumingiana* (vulnerable); *A. hirta* (vulnerable) and *A. microcarpa* (vulnerable) (Oldfield et al. 1998). Agarwood is now found occasionally in the wilds of Vietnam, Laos, Burma and Cambodia. It is no longer found in India, Bangladesh, Thailand or China (Aktar and Neelim, 2008).

*Aquilaria malaccensis* is included in the World List of Threatened Trees (Oldfield et al., 1998). The IUCN Red list classifies this species as vulnerable. The export of native *A. malaccensis* products, except oil, is currently banned in India. At present, species are becoming increasingly scarce due to forest degradation and other harvesting. As scarcity leads to higher value, these products tend to attract greater outside attention and investment. This, in turn, reinforces the trend toward the alienation of local population from their traditional resources. Many NWFPs in the Asia-Pacific region are becoming scarce or are being harvested destructively due to increasing commercialization. These products includes dammar resin, gaharu trees (*A. malaccensis*) containing fragrant heartwood, an assortment of barks, roots, stems and leaves used as medicines (Giano 1990 cited in Peters 1996,)

*A. malaccensis* first came to the attention of the Plants Committee in the late 1960s, when the committee determined that a review of the implementation of the CITES Appendix II TRAFFIC was hired as the consultant to prepare a review of CITES implementation for
the species, and as interim report was submitted to the 9th Meeting of the Plants Committee (Darwin, June 1999. cited in CITES 2003).

The revenue to the local people must be kept in mind while involving them in the process of conservation. Agar tree is a commercially valuable. But due to deforestation the species is diminishing day by day from our forests. It may result in a great loss in the trade of forestry which may lead to loss in the economy of the nation. Besides this ecological aspect, the species has some biological roles to play in combination with fungus. So, a research became essential to acquaint with the domestication and conservation of the species in the home gardens of local people.