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## SCOPE AND DIMENSION OF PATCHOULI (*POGOSTEMON CABLIN BENTH.*), AGAR (*AQUILLARIA AGALLOCHA ROXB.*) AND SANDALWOOD (*SANTALUM ALBUM LINN.*) CULTIVATION THROUGH JOINT FOREST MANAGEMENT IN ASSAM, INDIA

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### ABSTRACT

North-Eastern states of India have mostly tropical to subtropical humid climate and fertile soil, annual rainfall varying from 1500 mm to 3750 mm and temperature ranges between 5°C to 35°C. It offers diversified agro-climatic conditions for the cultivation of number of essential oil yielding crops. Patchouli (*Pogostemon cablin* Benth.), a short term aromatic crop (2-3 years) grows luxuriantly as intercrop under two long term essential oil yielding crops such as agar and sandalwood in forest of North-East India upto an elevation of  $\pm 500$  meters. Warm and humid climate with a dry spell not longer than 12-14 weeks is most ideal for patchouli belongs to family Lamiaceae. Its shade dry cured leaves after steam distillation yield essential oil of commerce, which is high valued in international market. When wood of standing tree of *Aquilaria* spp. commonly *A. mallacensis* and *A. agallocha* are infected by a mixed colony of fungi, viz. *Aspergillus*, *Fusarium*, *Alternaria* etc. agar oil or agaru formed which is also high valued. Sandalwood is another high value aromatic plant with increasing demand belongs to the family Thymelaeaceae. The forest department through its various schemes provide a promising scope of inclusion of different horticulture crops in recouping the degraded forest land. Forest villagers mostly located in thinly stand forest where patchouli could be a bumper crop for 2-3 years rotation cycle. Joint Forest Management Policy may encourage forest dwellers to grow these crops to be benefited economically.

**Key words :** Patchouli, Agar, Sandalwood, Joint Forest Management, Intercrop.

### Introduction

North Eastern States of India have mostly sub tropical to tropical humid climate and fertile soil, annual rainfall varying from 1500 mm to 37500 mm and temperature ranges between 5°C to 32°C offers diversified agro-climatic conditions for cultivation of number of essential oil yielding crops. Essential oil obtained from distillation of woods, leaves, flowers, fruits and roots of a large number of plants are one of the major raw materials for perfumes, cosmetics, flavoring agents and medicines (Lee and Mohamed, 2016).

Assam has the total geographical area of 78,435 sq. km. out of which total very dense forest is 2795 sq. km, moderately dense forest is around 10,209 sq. km and

open degraded forest is around 15,253 sq.km [India State Forest Report (ISFR), 2019]. Total villages in Assam are 24,685 where 2140 (0.22 million hectare) are forest village.

Patchouli (*Pogostemon cablin* Benth.), an aromatic herb, belongs to family Lamiaceae. Patchouli is distributed in the Indo-Malaysian and Sino-Japanese regions (Fatima *et al.*, 2023). Patchouli, a short term crop (2-3 years) grown luxuriantly as intercrop under two long term essential oil yielding crop, agar and sandalwood in forest of North-East India up to an elevation of  $\pm 500$  meters. Warm and humid climate with a dry spell not longer than 12-14 weeks is most ideal for patchouli. Patchouli is an erect, branched, pubescent perennial herb (Krithika,

2022). Its shade dried leaves (For curing dry leaves to compactly stored in gunny bag) after steam distillation yield essential oil of commerce (Verma *et al.*, 2019). The essential oil is one of the best fixatives for heavy perfume which imparts strength, strong character, alluring notes and lasting qualities. Natural fragrances like sandalwood, rose, jasmine, vetiver, agarwood, and patchouli are complex mixtures of organic molecules, which cannot be produced in the laboratory (Zhu *et al.*, 2017). Apart from essential oil, Patchouli also contain variety of phytochemicals such as terpenoids, phytosterols, flavonoids, organic acids, lignins, glycosides, alcohols, pyrone and aldehydes (Junren *et al.*, 2021)

The genus *Aquilaria* belongs to the family Thymelaeaceae, comprises 21 species. Among them, *A. malacensis* Roxb. and *A. agallocha* Roxb. are economically the most exploited species (Barden *et al.*, 2000). Height of the species of *Aquilaria* ranges from 15-40 meters, young short silky or without silky. Leaves are slightly leathery, alternate, linear, lanceolate, flower pale white to greenish white very small fruit capsular, velvety. Flowering starts from April onwards and continued up to July (Elias *et al.*, 2017). Time required for fruit setting is about one month and seed maturation is about two months. The harvesting age of agar tree for commercial purpose is not governed by their physical age, growth rate or physiological maturity. The heart wood of *Aquilaria* is the main source of resinous wood which is formed to heal the wound in response to fungal infection or human caused stimuli (Tan *et al.*, 2019). When wood of standing trees of *Aquilaria* species such as *A. malacensis* and *A. agallocha* are infected by a mixture colony of fungi, such as *Aspergillus*, *Fusarium*, *Alternaria* etc. agar oil or agar formed (Barthakur *et al.*, 2000). Agar is the dark brown oleoresin, secreted as a protective measure by the tree. Under normal conditions, infection starts from the age 5 years onwards (Naziz *et al.*, 2019). Agarwood formation takes longer time up to 30-40 years or even more. In agarwood plantation, if proper infection proceed, calculated net return is approximately Rs. 70,000/ per acre per year (Ahmed and Gogoi, 2000).

Sandalwood (*Santalum album* L.) is another high value aromatic plant with increasing demand belongs to family Santalaceae. It is small fragrant tree with slender branches up to height of 6 meter. Softwood is white and the heartwood is yellowish brown and strongly scented (Boruah *et al.*, 2023). On steam distillation of the heartwood of sandalwood, oil is obtained which is widely used in perfume, cosmetics, and drug industries (Yadav *et al.*, 2023). The sweet scented wood is itself much in

used for chandan paste and in carrying out chests and boxes. The tree grows wild in India and is cultivated in some other countries as well.

## Materials and Methods

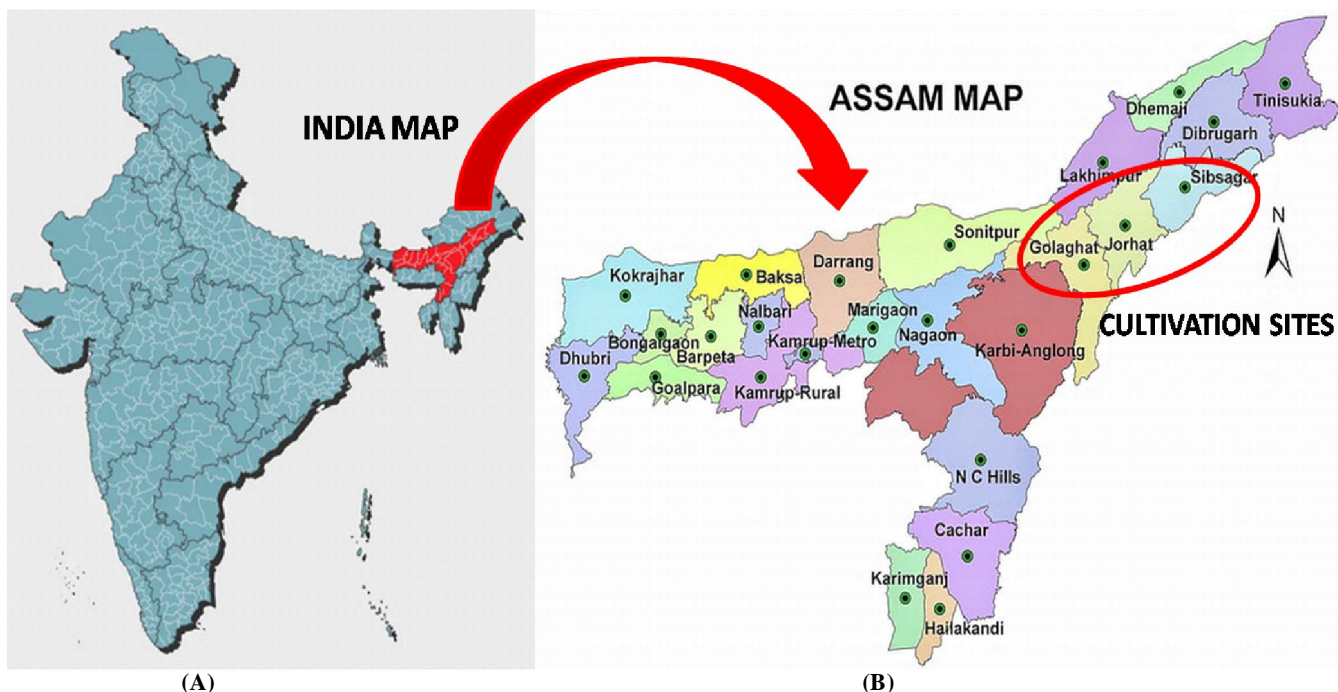
### Joint Forest management

The concept of Joint Forest Management (JFM) started way back in 1988, where the National Forest Policy encroach upon ecological security and people's participation and regeneration of the degraded forest. Government of Assam issued a notification adopting JFM on 10-11-98. Area under JFM in the state covers about 3.06 (in thousands) hectare. As per this resolution degraded forest area would be taken up for practicing under JFM (Fig. 1). Micro planes are prepared for those villages, which mainly depends upon the forest for their basic needs, mostly situated in the nearby areas of the reserve forest. Recently, revolving fund scheme of JFM provides effective utilization of resources and more meaningful protection of the forest vis-à-vis enhancement of per capita income of the people involved in JFM. Under area to be managed intensively, species to be planted are chosen by the people involved in JFM. Species which are important for the people depending upon their consumption pattern, utility and suitability are to be planted. The main emphasis is in the development of this model of JFM is the choice of the species which is to be planted in the area available. Most important character of these species should be:

- A- Planting and harvesting techniques should be simple
- B- The species should be able to give early and sustained returns over a period of time
- C- Investment in planting and management should be minimum
- D- The species should be well adopted to the prevailing climatic conditions

### Prospect and economy of patchouli, agar and sandalwood in JFM

The forest department through its various schemes provides a promising scope of inclusion of different horticulture crops in recouping the degraded forest land. Forest of Assam is very suitable for the growth of patchouli, agar and sandalwood simultaneously. It is observed that sandalwood could be potential plantation crop in the region particularly in low rainfall area comprising Hojai, Karbi-Anglong and NC hills. As sandalwood tree is a semi-root parasite it requires a secondary host. Agar could be good secondary host for



**Fig. 1 :** Map of India (A) showing Assam (B) and plant cultivation sites.

sandalwood. Patchouli can also grow luxuriantly in thinned forest of Assam under the shade of agar or sandalwood (Fig. 2).

**Results and Discussion**

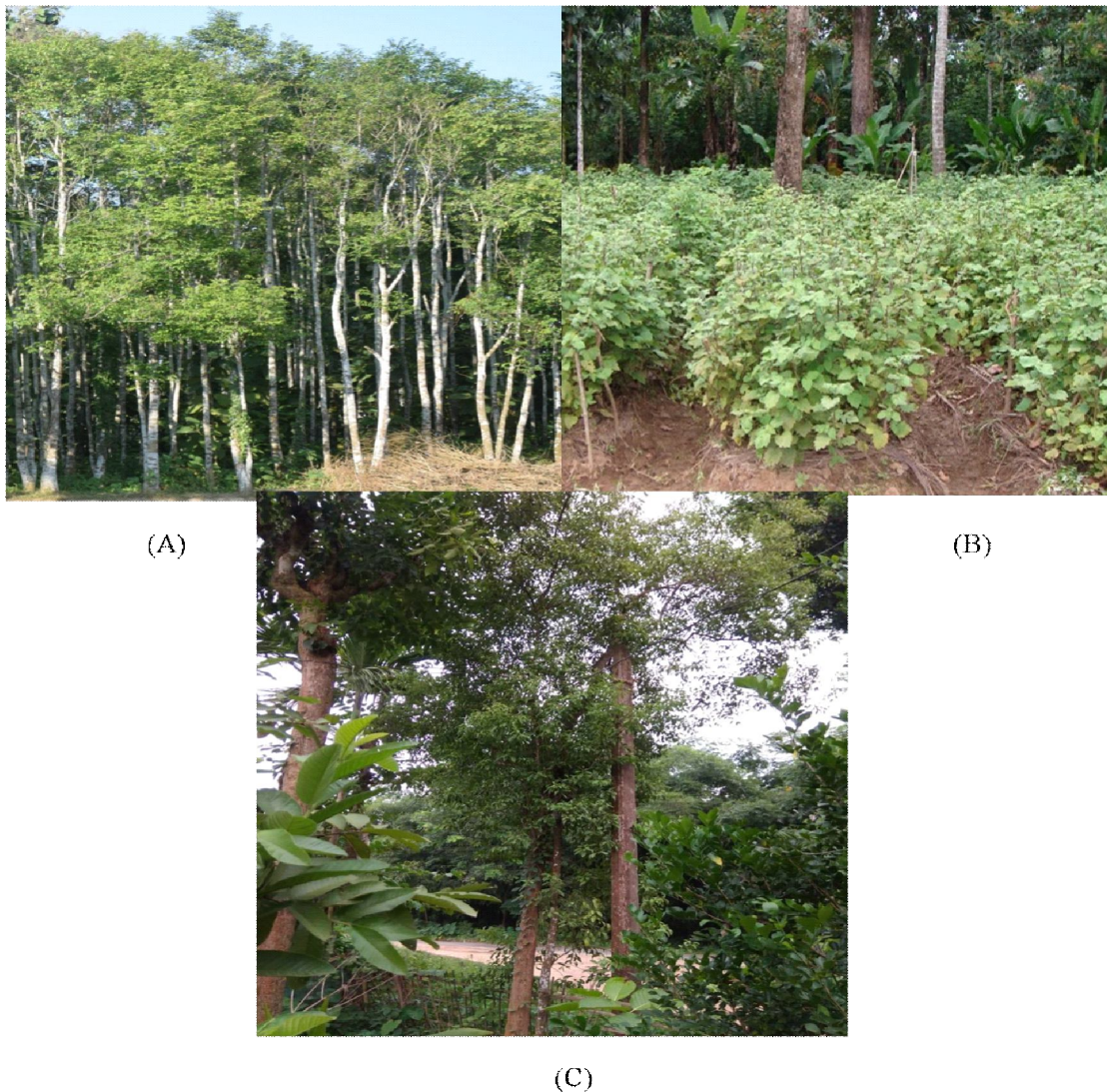
Forest villagers are mostly poor people and having no dependable cash crops to meet their basic requirements. They fall prey to smugglers from outside in forest destruction finding no other means. These villagers are mostly located in thinly stand forest, where patchouli could be a bumper crop for 2-3 years rotation cycle. Joint Forest Management Policy may encourage forest dwellers to grow these crops to be benefitted

economically.

Though patchouli and sandalwood are new to North East States, agar tree is found to be distributed in Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya in wild as well as in sporadic cultivation in limited scale (Ahmed and Gogoi, 2000). The plants occur at varying population densities in the district of Sibsagar, Jorhat, Golaghat, Dibrugarh, North Lakhimpur, Nagaon, Darang, Sonitpur, Goalpara, Kokrajhar, Karbi-Anglong, NC Hills and Barak Valley. We have focused in tree district namely Sibsagar, Jorhat and Golaghat (Table 1). Government of Nagaland appreciably drawn up a

**Table 1 :** Plants cultivated under JFM Assam with study sites.

S. no.	Division	Area	Cultivated plants
1	Golaghat	Kamargaon	<i>Aquilaria agallocha</i> (Agar) <i>Pogostemon cablin</i> (Patchouli) <i>Santalum album</i> (Sandalwood)
		Athkhelia	
		Numaligarh	
		Kamargaon	
2	Jorhat	Titabor	<i>Aquilaria agallocha</i> (Agar) <i>Pogostemon cablin</i> (Patchouli) <i>Santalum album</i> (Sandalwood)
		Mariani	
		Sakalating	
		Jorhat proper	
3	Sibsagar	Jaisager	<i>Aquilaria agallocha</i> (Agar) <i>Pogostemon cablin</i> (Patchouli) <i>Santalum album</i> (Sandalwood)
		Moran	
		Sibsagar proper	



**Fig. 2 :** (A) *Aquilaria agallocha* (Agar), (B) *Pogostemon cablin* (Patchouli) and (C) *Santalum album* (Sandalwood) plants at cultivation sites.

elaborate programme of commercial Agar plantation through Nagaland Corporation of Rubber and Agar plantation since 1993 (Giri *et al.*, 2021).

The world trade of essential oil is worth a billion dollars, which support a perfumery and cosmetics industries of several billion dollars (Abdin, 2014). India enjoys a dominating role in the global perfumery scenario with the supply of its famous sandalwood oil and agarwood oil both in quantity and quality. There is significant global market for patchouli oil (Ador *et al.*, 2021). Currently more than 1000 tons of patchouli oil is produced annually. Major producing economy of patchouli oil is Indonesia. China and India produce only small quantity in comparison to Indonesia. India annually consumes nearly 300 tons only.

## Conclusion

The North East India covers about 8% of area of total geographical area of India. Its vast diversity of edaphic factors and ecological conditions, make it suitable habitat for diverse life forms, which provide livelihood to the marginal farmers. Cultivation of crops like patchouli, agar and sandalwood is helpful not only to overcome their poverty but also conserve biodiversity. Therefore, Government patronage and proper management will makes our forest dwellers and poor farmers economically strengthened by cultivating crops like patchouli, agar and sandalwood through JFR.

## Conflicts of interest

The authors declare no competing interests.

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