ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 42(1): 191-196, March 2017 **Short Communication**

THE ECONOMIC BENEFIT OF AGARWOOD PRODUCTION THROUGH AERATION METHOD INTO THE *Aquilaria malaccensis* TREE IN BANGLADESH

M. CHOWDHURY[1,2], A. RAHMAN[3], M. D. HUSSAIN[1] AND E. KABIR[1]

Keywords: Agarwood, usage, aeration technique, benefit-cost ratio

Agarwood is a precious incense substance which is extremely rare. This fragrant wood is only formed in *Aquilaria* and *Gyrinops* species under family the Thymelaeaceae (Blanchette, 2006). It is a diseased tissues located in the heartwood which is a resultant substance of plant defense against outside attacks and impacts, such as (i) naturally pathological infection (insects, fungi, bacteria etc), (ii) mechanical injury (impacted by human being or outer factors), (iii) wounding and pathological infection (artificial inducement), and (iv) floristic composition of vegetational cover (companion plants, insects) (Ba, 2010). To preserve these wounds, initially, plant secretes a brown color oleoresin to the injured place. With the passage of time, it becomes dense and dark in color. The more resin deposit, the more quality ensure and the precious wood would be formed. It has been using for 3000 years in the China, Japan, India, and especially in Arabian countries (Le, 2003) and known by many names depending on place and cultures such as Agar (Bangladesh, India), Aguru (Sanskrit), Oud (Arabic), Eagle/Agilawood (Europe) (Akter *et al*., 2013).

Agarwood has been used for medicinal purposes for thousands of years, and still using in Ayurvedic, Tibetan and traditional East Asian medicine (Chakrabarty *et al*., 1994), aromatherapy (LaFrankie, 1994), pharmaceutical tinctures (Van Beek & Phillips, 1999), asthma, rheumatism and other body pain treatment (Hajar, 2013). Many religious groups use it as a meditation incense to calm the mind and spirit. It is also the main ingredient of perfumery as well as cosmetic industry (Chaudhari, 1993). In the Middle East, both agarwood smoke and oil are customarily used as perfume (Chakrabarty *et al*., 1994).

International agarwood market has a terrible experience of price fluctuation. By 1970s, it was sold up to $42.5 and then raised straightly $1250 and $2500 per kg in 2000 and 2005, respectively (Abdin, 2014). First-grade agarwood is one of the most expensive natural raw materials in the world. Singapore trades agarwood $1.2 billion alone each year (Hansen, 2000). The trading value of pure agar oil is $30,000 to 40,000 per kilogram (Abdin, 2014). Based on resin presence, agarwood chips sell from $30 to $10,000 per kilogram (Babatunde, 2015). Akter *et al.,* (2013) reported that in the year of 2013, the global market for agar oil and

[1]Dept. of Farm Power and Machinery, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh, [2]Dept. of Biosystems Machinery Engineering, [3]Dept. of Environment and Forest recourses, Chungnam National University, Daejeon, South Korea.

other agarwood related products was estimated in the range of $6 to 8 billion and the major agar oil industrial buyer expects to exceed it up to $36 billion in 2017 (http://www.ouddh. com/?cid =2065877).

Natural agarwood formation is difficult and harvesting wood from those trees causes greatly to the near-extinction of natural stands of trees (Blanchette, 2006). In the context of Bangladesh, agar trees are being cultivated in many places on a large scale but the agarwood farmers are failed to get the proper profit because of their unfamiliarity with the proper and scientific inoculation methods. They are used to practice the nailing method which is time-consuming and yield is very poor. Aeration method might be a suitable solution for this problem as it is easy to inoculate, inoculation materials are locally available, comparatively low cost and as long as the wound remains open to the air, agarwood will increasingly accumulate. Keeping the above facts in view, the objective is to evaluate the economic benefit of agarwood cultivation through aeration technique into agar trees.

The experiment was performed at Birisiri, Durgapur Upazila of Netrakona district, Bangladesh during 10th March 2013 to 30th May 2014. Geographically it is located in 25°10" N latitude and 90°44" E longitude at an elevation of 42 m above the sea level. The site falls under both the Agro-ecological Zone 9 and 22 (UNDP & FAO, 1990). Three Aquilaria malaccensis trees were selected for artificial inducement at Birisiri natural agar garden. The trees were selected on the basis of age and trunk diameter. All trees were 8-9 years old and trunk diameters were between 15-19 cm.

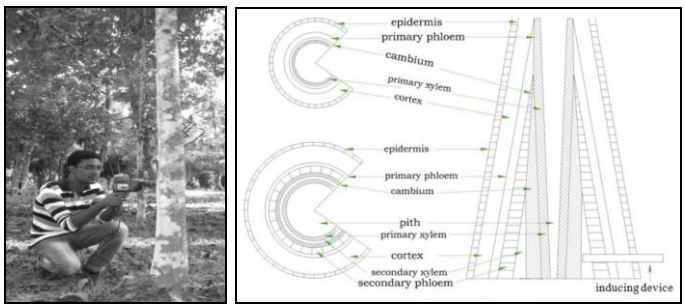

Fig. 1. Photographic and cross-sectional view of wounding.

Selected trees were wounded by making 7/8" drilled hole up to the xylem to a depth of approximately 5.0 cm using electric driller. Wounds were made in a spiral shape separated by 15 cm from each other. Drilling was started from the bottom of the tree trunk and ended at the tree branching point. All wounds were slightly sloped down wherein rainwater could not stand. 15 cm long and 2 cm dia Plastic tubes were inserted into the wounds. The tubes were kept extended 10 cm from the outer surface so that the holes could not be closed for many years and a periodic re-wounding facilitates air availability into the inner wounded xylem. Finally, 5g+5g+15g=20g sodium bisulfite, Difco yeast extract, and iron powder,

respectively were inserted each tube at a ratio 1:1:3. All inserted tubes were rotated in a 2-month interval.

After 15 months of artificial inducement three trees were harvested and brought to the workshop of farm Power and Machinery department, BAU for analysis. The resin formatted areas were separated by splitting the trees through the wounded region and weighted.

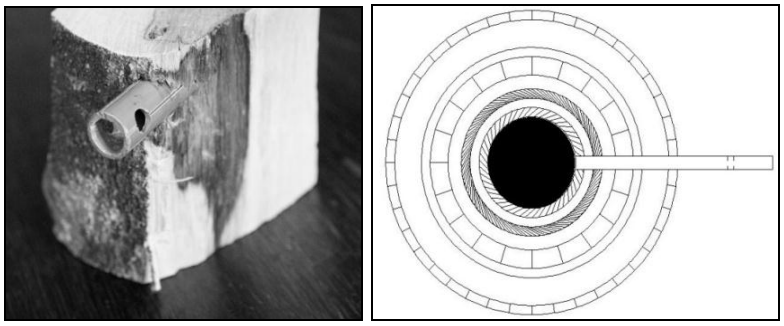

Fig. 2. Photographic and cross-sectional view of harvested tree block.

Table 1. Cost involvement in different growing stages (Based on Ahmed, 2010)

Head of Expenditure	Unit of cost	Cost			
		1st year	**2nd** year	**3rd** year	**4th to 9th** year
Seedling	BDT/seedling	10	-	-	-
Pit making and transplant (labour)	BDT/tree	5	-	-	-
Bamboo stick	BDT/ tree	5	5	-	–
Cow dung	BDT/pit	5	5	5	-
Urea	BDT/pit	-	4.67	7.05	11.40
TSP	BDT/pit	-	12.43	18.74	31.2
MOP	BDT/pit	-	1.76	2.65	4.40
DAP	BDT/pit	-	4.91	7.42	4.0
Irrigation and fertilizer	BDT/tree	5	-	-	-
Inoculation (materials)	BDT/tree	-	-	-	300
Inoculation (labour)					300
After care	BDT/ year	5	5	5	10
Land use up to 15 years	BDT/tree	15	-	-	-
Interest on operating capital (up to 15 years)	BDT/tree	105	-	-	-
Total Expenditure	BDT/tree	155	38.77	45.86	661
Total Expenditure **up** to **9th** year	BDT/tree	**BDT 900.63 ~ US$12**			

BDT=Tk. (Bangladesh); US$=American dollar

Each tree had 45 holes. Each hole was filled up with sodium bisulfate, yeast extract and iron powder @ 5g : 5g : 15g at 1:1:3 ratio. The total inoculation expenditure was $35 per tree (Table 2)

The total expenditure for one agar tree cultivation up to 10 years was US$ 12 (Table 1) and the inoculation expenditure was US$35 (Table 2).

Table 2. Cost involvement in inoculation stage

Expenditure	Unit of cost (Tk./Kg)	Amount per hole	Cost (BDT)
Sodium bisulfate	1200[a]	5g	6
Yeast extract	3000[b]	5g	15
Iron powder	1200[b]	15g	18
Plastic pipe	20[b]	15 cm	20
Total Expenditure	BDT per hole		59
Total cost for **45** holes	BDT per tree		BDT 2655 ~ US$35

[a] Bdbazar24.com, [b] Local market price; US$= Tk. 75.86.

Agarwood formation is a result of resin synthesis in the xylem tissues of *Aquilaria* plant. This resin is a chemical substance which consists of aromatic, sesquiterpenes, fatty acids, chromones, phenolic and specially 3-phenyl-2-butanone and alpha-cubebene (Naef, 2011; Hashim *et al*., 2014). Artificial agarwood or agar oil formation is quite impossible as it is a composition of numerous volatile and semi-volatile compounds. However, the chemical composition of cultivated agarwood is almost similar with naturally inoculated agarwood (Espinoza *et al*., 2014).

Cost involvement in different processing stages i.e. nursing of tree (up to 10 year), carrying, logging, chipping, collection of inoculants and establishment were 500, 50, 50, 100, 100 and 50 BDT per tree, respectively. So the total expenditure of agarwood processing was BDT 850 ~ US$ 11 per tree. Grand total expenditure of agar wood harvesting = Total cultivation expenditure + total inoculation expenditure + total processing expenditure = US$(12+35+11) per tree = US$ 58 per tree (Tk. 4399.88).

Each tree gave yield around 55-75 kg of useful wood which can be graded as fresh, semi-resinous and resinous woods. The value of wood in the international market ranges from a few dollars a kilogram for the lowest quality to over thousands of dollars for the top quality (Table 3).

Table 3. Gross return estimation from a ten years old agar tree

Types of wood	Usage	Unit of price (Tk./Kg)	Amount of wood (Kg/tree)	Gross return (Tk./tree)
Fresh wood	Cooking	9.86[a]	50	379.3
Semi-resinous wood	Incense stick	379.3[b]	17	6448.1
Resinous wood	agarwood	682744	0.5	34137
			Total	40964.4

[a] local market price, [b] alibaba.com, 1 US$ = Tk. 75.86

Net return was calculated as the difference between gross return and gross cost as follows:

Net return = Gross return - Gross cost = Tk. (40964.4 - 4399.88) = Tk. 36564.52.

Benefit-cost ratio (BCR) is the ratio of gross return divided by gross cost. In this experiment, BCR was 40964.4/4399.88 = 9.31 per tree where BCR from cash crop like High Yielding Variety (HYV) Boro, HYV Aman, Wheat, HYV Maize, Jute, Lentil and fruit like banana are 1.14-1.28, 1.10-1.23, 1.12-1.27, 1.21-2.85, 1.17-1.24, 1.18-1.21 and 3.69, respectively (Rahman *et al*., 2013; Kamal *et al*., 2015; Rahman *et al*., 2016). Though agar tree takes 10/11 years for giving yield which is 10/11 folds of any cereal crop, total profit included intercropping in agarwood cultivation will be higher than any other crops.

Let, the total number of trees is 1500. At the 8/9th year, we may harvest about 40% (600 Nos.) of the total with a view to thinning out the tree population for further growth and development of remaining 900 trees along with to generate an interim income. The final harvesting would be done at the 13-15th year. Each year after 10th, yield and income from an inoculated agar tree will increase gradually.

Based on the cost-effective assessment, it could be concluded that agarwood production using aeration method would be more economically profitable for the rural agar tree growers rather than other agricultural crops in Bangladesh. From this experiment, obtained agarwood (resinous) was 0.5 kg from a 10 years old agar tree. The gross expenditure, gross return, and benefit-cost ratio (BCR) were Tk. 4399.88, Tk. 40964.4 and 9.31 per tree, respectively. Depending on BCR analysis, it was clearly seen that agarwood production is highly profitable which could change the economic condition of the agarwood growers. There is a need to boost up its production and to identify the weak points for increasing the returns.

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