DISCOVERY

58(317), May 2022

Social perceptions on the problems and impacts of exotic tree plantation in private land at Sakhipur, Tangail, Bangladesh

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To Cite:
Rahman MM, Khan SA. Social perceptions on the problems and impacts of exotic tree plantation in private land at Sakhipur, Tangail, Bangladesh. *Discovery*, 2022, 58(317), 409-422

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Peer-Review History
Received: 24 February 2022
Reviewed & Revised: 27/February/2022 to 09/April/2022
Accepted: 11 April 2022
Published: May 2022

Peer-Review Model
External peer-review was done through double-blind method.

ABSTRACT

This study was carried out to investigate the social impacts of monoculture of exotic tree species *Acacia auriculiformis*, *Eucalyptus camadulensis* and *Swietenia macrophylla* of the local people in Sakhipur area of Tangail district. Data were collected from thirty woodlots plots of exotic tree species which were located in private land at Sakhipur through rigorous field visits. Local peoples were found to be interested to plant fast growing exotic timber species to meet their immediate financial demand within a short period. In order to meet the immediate financial demand within a short period, the local peoples were found to be interested to plant fast growing exotic timber species in the study area. In Sakhipur and its adjacent areas, the monoculture of exotic species have a promising prospect and also seems financially profitable for the short-term projects, but if the long-term perspectives are considered then ultimately it is not economically viable and not so appropriate to ensure conservation of biodiversity and ecosystem. It is reported during the questionnaire survey that, the villagers and tree growers depicted some problems of the exotic species, such as the trees of exotic species had a low number of twigs and leaves that not decompose after falling on the ground, they absorb more ground water that other trees hardly grow under them; they allow minimum collection of fuel wood; and growth of crops is slow under the exotic trees plots etc. It is concluded by the study that, the monoculture of exotic tree species should be discouraged for afforestation or reforestation but might be operational in some fellow, degraded or specified lands. Sakhipur of Tangail district is one of the areas that harbor massive plantations of exotic tree species. Therefore, Sakhipur of Tangail district is an appropriate area for conducting a social study on exotic tree plantation. Considering the facts mentioned above and other resources limitation, it is evident that still there is a large scope of studying social impacts exotic tree species plantation in the study areas.

Key words: Monoculture, exotic, woodlot, *Acacia*, *Eucalyptus*

1. INTRODUCTION

Tangail is one of the pioneer districts where the community people, farmers, NGOs raised huge plantations of *Acacia* spp. and some of *Eucalyptus* and *Swietenia*

Jacq. Enum. in their homesteads, marginal lands, fallow lands and farm lands to get more economic return within short period of time. *Acacia auriculiformis* and *Eucalyptus camaldulensis* are most commonly used in localities private land because of their fast growing characteristics and production of high volumes timber, short rotation, non-palatability to grazing animals and ability to thrive in poor soils. In Sakhipur upazila of Tangail district, there are very few number of *Eucalyptus* and *Swietenia* species woodlot plots were found. Hence, the major percentage of woodland owners prefer fast growing exotic tree species especially *Acacia* as it was delivering economic return with in very short span of time (±10 years). The homestead or village forests as well as woodlots were supplying most of the national demands for timber, fuel, fruits and biomass (Rahman et al., 2022). The private owned forests cover in turn was depleting rapidly to meet the crying need of ever increasing population of Bangladesh. The country had limited private forest resources in homestead & farmland that were managed through traditional systems by the local people. Timber and other forest products in village forest were usually supplied more than 80% of the total production of the country. Government and non governmenr agencies are accelerating the process of tree plantation all over the country to filled up the gaps of demand and supply of forest resources especially timber and fuel wood (FAO/UNDP, 1981). Number of authors (e.g. Brockerhoff *et al*. 2008; Paritsis and Aizen 2008; Chen et al. 2013) were studied the effects of exotic tree plantations on ecosystem as well as biodiversity functioning. However, the widespread use of exotic tree species raises environmental and isocio-economic ssues because of its impacts on landuse pattern, land management, ecosystem and the environment, as well as its influence on wood markets (Felton et al. 2013). There are number of studies carried out on tree plantation programs in Sal (*Shorea robusta*) forest tract (e.g. Alam *et al*., 2008). Most of the plantations in private land (*i.e*. woodlot) rely on exotic species because of high productivity for fueld wood and timber, wide site adaptibility as well as quick economic returns (Akkasaeng *et al*.,1989; Das, 2008; Duguma and Tonye, 1994; Kabir and Webb, 2005; Kamara and Maghembe, 1994; Rahman, 2003; and NAS, 1980).

In contrary Zhang and Fu (2009) reported loss of native tree species in many areas in the world due to planting of fast growing exotic species. It is widely accepted by the community people that managing forests at private level aims earn money, save the land from encroachment, ensure a scope of employment and income generation, social development and be a model of sustainable land management practice (Alam *et al*., 2008). Evans and Turnbull (2004) opined that in tropical countries the huge planted forests is growing to improve the local livelihoods of poor people and to satisfy the ever-growing global demands for wood products. The exotic tree species plantation both at public land had got momentum in the last two decades which helped to improve the social condition of the rural people through creating enabling environment to generate income and employment, especially in nurseries, plantation programs and timber business as well. Ali (2009) assessed the contribution of social forestry program in public land in socio-economic improvement of the beneficiaries and poverty alleviation in Gazipur and Tangail districts which contributed to change their attitude to get income from the plantation. The research concluded that, the plantation programs through exotic species have improved the social condition of the participants. In a study Kabir and Webb (2005) emphasized on the rural communities should get preferences of in selecting suitable tree species for future woodlot establishment where market might affect local people's choice of species. Hossain *et al.* (1998b) and Chowdhury (1982) reported from social point of views that, the monoculture woodlot have some advantages over natural forest, such as concentrated biomass production (i.e. high productivity) and ability to choose species with desirable characteristics etc (Elfving et al. 2001; Rytter and Stener 2005; Paquette and Messier 2010; Nelson et al. 2011; Tullus et al. 2012). Hoever, *Acacia auriculiformis* is usually blamed for pollen allergy, there are no detail studies in favor of this criticism. Moreover, it is reported that apart from the *Acacia* species there are some grasses and weeds that are more responsible for pollen allergy (Hossain, 2003). Moreover few researcher articulated from their research that the exotic species negatively affect the environment and ecosystems, pose threat to indigenous plants and wildlife species, soil ecology and dynamics, and agricultural ecosystems (Randall, 1996; Vitousek *et al*., 1996; Williamson and Fitter, 1996; Kaiser, 1999; D'Antonio *et al*. 2001; Hulme, 2003; Kil *et al*., 2004; Pimentel *et al*., 2005; and Simberloff, 2005; Dogra *et al*., 2010).

As a part of social development, exotic tree plantation in private land (scattered or woodlot block plantation) helps in improving the social condition of the rural people by generating income and employment (Gwambene, 2020). On the other hand, the consequence or advantage and/or disadvantage of the plantation programs with exotic species is a matter of great debate by the community people and scientist. A number of research on plantations of exotic species were executed by a number of researchers (Islam *et al*., 2003; Ara *et al*., 1989 and Davidson and Das, 1985) and these studies find out positive social impact derived from plantation. It is analysed that, the previous studies on social perception and impact of exotic tree species cultivation did not give proper attention to the Sakhipur areas though it was a good entry point of research area. None of the previous studies assessed the impacts, social perception and development of monoculture of exotic tree species combindly in comparison to indigenous tree species of Sal forest areas of Tangail. The study was taken to know the extent of social aspects, problems as well as impacts of the monoculture plantations of fast growing exotic species (*Acacia auriculiformis*, *Eucalyptus camadulensis* and *Swietenia macrphylla*) formed in private lands of the study area. Published information and research articles on the social impacts of plantation of exotic

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species on the Sakhipur areas of Tangail were not found. This study will also explore which extent of social impacts are generating through the plantation of fast growing exotic species.

2. MATERIALS AND METHODS

Study area and location

Sakhipur is situated in 80 km north from the capital city Dhaka. It is located between 24°11′and 24°26′ north latitudes; and between 90°04′ and 90°18′ east longitudes The Sakhipur upazila occupies an area of 435 sq km, bounded on the north by Ghatail upazila on the east by Bhaluka upazila of Mymensingh district and Sreepur upazila of Gazipur district, on the south by Mirzapur upazila and Kaliakair upazila of Gazipur district and on the west by Basail and Kalihati upazilas (BBS, 2012). This area is a part of Madhupur tract of 'Sal' forest. The floristic composition, wildlife and forest characteristics of this area are almost similar to that of other parts of Madhupur 'Sal' forests. According to the 2011 Bangladesh census, Sakhipur harbors a total of 277685 population with density of 638 per sq km. Males constitute 47.55% of the population, and females 52.44%. Sakhipur has an average literacy rate of 41.1% (male 44.4% and female 38.1%). Transport found in this area were horse carriage, bullock/buffalo cart, rickshaw/van, truc, bus, country boat and mechanized boat. Many of the households were connected with labor employment in abroad resulting solvency throughout the area. A huge number of local people were directly dependent on Sal forests resources for timber, fuelwood, medicinal plant for their livelihoods. The direct environmental threats in Sakhipur areas were change of land use system, high population growth, over exploitation of natural resources, fragmentation and loss of habitats, pollution, uncontrolled tourism, unsustainable agricultural practices, occurrence invasive alien species, monoculture of exotic species and heat stress.

Selection of research plots, data collection and analysis

In Sakhipur, Tangail the most of the plantations (monoculture woodlot) were done by fast growing exotic tree species i.e. *Acacia auriculiformis*, *Eucalyptus camaldulensis*, *Swietenia macrophylla* where *Acacia auriculiformis* occupies the major portion. A total of 30 private woodlots, including 20 of *Acacia auriculiformis*, 8 of *Eucalyptus camaldulensis*, and 2 of *Swietenia macrophylla* were selected from different parts of the Sakhipur, Tangail to analyzed socio-economic aspects. In order to collect the data a comprehensive semi-structured questionnaire was prepared (modified from Rahman, 2003) and accordingly respective data of the woodlot plots and tree growers were collected in 2010-11. A detail questionnaire survey and focus group discussion (FGD) were carried out with tree growers of the study areas and the necessary information were collected different aspects of plantation and local Sal forest management. In addition to the individual interviews and direct observation, participatory rural appraisal (PRA) was applied and in this relation FGD was also conducted. FGD were separately held with the beneficiaries, tree growers, local people, timber traders and related stakeholders. These discussions provided an overview and general contextual information of their activities, roles and responsibilities in traditional *Shorea* forest management and also their overall reaction in participatory forestry activities. Moreover, key informant interview (KII) was conducted with BFD officer and stakeholders to explore information and data from different corners including Sal forest management system as well as woodlot plantation in government forest land. NGOs staff, teachers, government officers, union parishad chairman and member, and local elites who provided important data on exotic tree species plantation (i.e. woodlot plantation) in private and government forest land.

In this research all the data collected in the plots (36 m x 36 m = 0.132 ha) were converted to one hectare in order to have better comparison and understanding. Data were statistically analyzed using SPSS software (version 16.0). One way ANOVA (DMRT) was used to test for significant differences ($P<0.05$) for marginal means of variables. Besides, data were also analyzed through Microsoft Excel.

3. RESULTS AND DISCUSSION

Information of the tree growers

Lands were found to be utilized primarily for farming, housing and minimal forestry (tree cultivation) purposes. The average land holding size per household/respondent was 0.88±0.76 ha, of which 54%, 29% and 17% was used for agricultural, tree plantation and homesteads purposes respectively. Land allocated for homestead was significantly smaller than that for agricultural activities. Traditionally farmers were used to grow cereal crops, vegetables and spices in their farm's lands. Agriculture was a major source of income for 70% households. Small to medium scale business, daily laborer, and jobs service were other major sources of household income. Especially, in case of private land, this study showed that, woodlot tree grower families depend on forest produce income for major purposes as they were investing land for long time. In the study area 80%, 30%, 83% and 13% households of the tree growers were engaged with the rearing of cow, goat, chicken and duck respectively besides buffalo and ships were found very

ISSN 2278–5469 EISSN 2278–5450 I OPEN ACCESS

small number in Sakhipur areas of Tangail district. The average annual income of the respondents was 195267±133340 BDT with a minimum of 36000 BDT to a maximum of 556000 BDT. This average annual income per household was consisted of 158567±110460 BDT from agricultural activities (76%) and 36700±64536 BDT from off-farm activities (24%). The major occupation of 70% respondents was agriculture and the rests (30%) were engaged in job service and others small business. The small to medium scale agricultural business, fish culture, daily laborer, and job service were other major sources of household income.

Survey results showed that, most of the respondent tree growers didn't exceed higher secondary levels and 83% of their lands were used for agricultural purposes as well as tree plantation, and only 17% for the dwelling house and homestead uses (Table 1 and Table 2). The rural households view trees as a ready source of income. Trees in the homestead or in woodlot in general and fruit trees in particular have a considerable share in the family income. The farmers have taken up the idea of planting tree in their cropland as an alternative resource for their household and/or livelihoods security. However, once the woodlot plantation established in the cropland, the farmers start harvesting the trees after 10 years to get the considerable economic benefit (separate income sources). In most cases, all of the farming activities are manual, undertaken with the help of family members and hired labor. Scoones (1998) depicted that the rural livelihood strategies are mostly reliant on agriculture as well as natural resources and this statement was certainly found to be true while executed household survey in the study areas.

Table 1. Private land woodlot tree growers basic information, Sakhipur, Tangail.

Age group	Respondent ID	Education	Occupation	Village	Woodlot tree species
26-40	27	Five	Agriculture	Panaullah para	*Acacia auriculiformis*
	28	Six	Agriculture	Panaullah para	*Acacia auriculiformis*
	24	Six	Business	Ballar chala	*Eucalyptus*
	12	Eight	Agriculture	Purba Para, Shola Protima	*Eucalyptus camadulensis*
	23	SSC	Agriculture	Ballar chala	*Acacia auriculiformis*
	2	SSC	Agriculture	Kalidas	*Acacia auriculiformis*
	17	SSC	Agri Business	Shola Protima	*Acacia auriculiformis*
	20	HSC	Agriculture	Shola Protima	*Eucalyptus camadulensis*
	9	HSC	Business	Bonki	*Acacia auriculiformis*
	30	HSC	UP Member	Protima Bonki	*Eucalyptus camadulensis*
42-50	11	Five	Agriculture	Sakhipur College Road	*Acacia auriculiformis*
	22	Five	Agriculture	Ballar chala	*Acacia auriculiformis*
	26	Five	Business	Panaullah para	*Acacia auriculiformis*
	21	Eight	Agriculture	Protima Bonki	*Eucalyptus camadulensis*
	7	Eight	Business	Sakhipur Sadar	*Eucalyptus camadulensis*
	1	Eight	Business	Kalidas	*Acacia auriculiformis*
	19	SSC	Agriculture	Purba Para, Protima Bonki	*Acacia auriculiformis*
	3	SSC	Agriculture	Kochua	*Acacia auriculiformis*
	18	SSC	UP Member	Shola Protima	*Acacia auriculiformis*
	10	HSC	Agriculture	Sakhipur Sadar	*Acacia auriculiformis*
	29	HSC	Business	Protima Bonki	*Eucalyptus camadulensis*
	5	MA	Teacher	GarhGobindapur	*Acacia auriculiformis*
55-81	15	Nil	Agriculture	Purba Para, Shola Protima	*Acacia auriculiformis*
	25	Nil	Agriculture	Ballar chala	*Acacia auriculiformis*
	4	Nil	Agriculture	Kochua	*Swietenia macrophylla*
	14	Eight	Agriculture	Kirton Khola	*Acacia auriculiformis*
	13	Five	Agriculture	Kochua	*Swietenia macrophylla*
	16	Eight	Agriculture	Garh Gobindapur	*Acacia auriculiformis*
	8	HSC	Agriculture	Sanbandha	*Acacia auriculiformis*
	6	HSC	Agriculture	Kahartali	*Eucalyptus camadulensis*

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Table 2. Private land woodlot tree growers household information, Sakhipur, Tangail.

Resp. ID no.	House members			Homestead site information				Specification of farmer's land			
	Total	Male	Female	House structure	Land	Soil	Drainage	Homestead land (ha)	Agricultural land (ha)	Land with tree/ vegetation cover (ha)	Total land (ha)
1	6	3	3	Kancha	Upland	Clay	Very Good	0.11	0.32	0.77	1.20
2	5	3	2	Kancha	Upland	Sandy	Very Good	0.40	0.90	0.40	1.70
3	4	3	1	Pacca	Upland	Sandy Loamy	Very Good	0.54	1.80	0.80	3.14
4	7	4	3	Kancha	Upland	Sandy Loamy	Very Good	0.22	0.20	0.04	0.46
5	4	1	3	Pacca	Plain land	Sandy Loamy	Good	0.05	0.20	0.13	0.38
6	9	5	4	Semi pacca	Plain Land	Clay	Good	0.32	0.05	0.26	0.63
7	4	2	2	Pacca	Plain Land	Clay	Good	0.02	0.12	0.40	0.54
8	6	3	3	Pacca	Plain Land	Clay	Good	0.40	1.40	1.32	3.12
9	7	2	5	Kancha	Plain Land	Clay	Good	0.15	0.07	0.11	0.33
10	7	2	5	Kancha	Low Land	Clay	Good	0.10	1.40	0.36	1.86
11	4	2	2	Kancha	Upland	Clay	Good	0.07	0.08	0.12	0.27
12	4	1	3	Semi Pacca	Plain Land	Sandy Loamy	Good	0.14	0.60	0.12	0.86
13	8	4	4	Kancha	Upland	Loamy	Good	0.07	0.16	0.26	0.49
14	7	3	4	Semi Pacca	Upland	Sandy Loamy	Good	0.08	0.28	0.16	0.53
15	9	4	5	Semi Pacca	Plain Land	Sandy Loamy	Good	0.19	0.30	0.12	0.61
16	7	3	4	Semi Pacca	Plain Land	Sandy Loamy	Good	0.09	0.20	0.20	0.49
17	4	1	3	Semi Pacca	Plain Land	Sandy Loamy	Good	0.22	1.60	0.18	2.00
18	3	2	1	Semi Pacca	Plain Land	Sandy Loamy	Good	0.50	0.28	0.10	0.88
19	4	3	1	Kancha	Plain Land	Sandy Land	Good	0.12	0.44	0.40	0.96
20	4	2	2	Semi Pacca	Plain Land	Sandy Loamy	Good	0.12	0.80	0.12	1.04
21	5	2	3	Semi Pacca	Plain Land	Sandy Loamy	Good	0.12	0.60	0.06	0.78
22	5	2	3	Kancha	Plain Land	Loamy	Good	0.05	0.20	0.26	0.52
23	6	4	2	Kancha	Plain Land	Loamy	Good	0.05	0.24	0.13	0.42
24	5	2	3	Kancha	Plain Land	Sandy	Good	0.02	0.20	0.13	0.35
25	2	1	1	Kancha	Plain Land	Clay	Good	0.02	0.32	0.13	0.48
26	5	3	2	Pacca	Plain land	Lomy	Good	0.04	0.40	0.13	0.57
27	4	3	1	Kancha	Plain land	Lomy	Good	0.02	0.24	0.13	0.39
28	5	3	2	Kancha	Plain land	Sandy Loamy	Good	0.02	0.20	0.13	0.35
29	5	3	2	Pacca	Upland	Clay	Good	0.06	0.40	0.13	0.59
30	5	3	2	Pacca	Plain land	Lomy	Good	0.06	0.22	0.13	0.41
Ave.±SD	5.3±1.7	2.6±1.0	2.7± 1.2					0.15±0.14	0.47±0.48	0.26±0.27	0.88±0.76
Percenta		49%	51%					17%	54%	29%	100%

Characteristics and factors of plantation

Seedlings/saplings were planted by their own initiatives along with BFD and NGOs (especially Proshika) promotional activities and technical support. In this relation, social perception and impact assessment was done to determine the factors that influenced the farmers in exotic tree planting decisions. As a part of this study, the factors influencing farmer's decisions, species selection, mind-set about tree planting and benefits, and environmental aspect were analyzed. Usually, saplings were not available in the BFD nurseries and most of the saplings were collected from local market and private nurseries. Questionnaire survey revealed that, among the 30 woodlot tree growers (respondent), 60% and 40% tree growers were collected seedlings from the local nurseries and local market respectively. All the farmers were used to plant height seedlings and even more height seedlings (Saplings) in the plantations which were one year old and even more because they preferred to plant larger seedlings to get the benefit of nursing cost and protection from small cattle's or goats. Most of the tree growers opined that, they preferred to plant exotic timber tree species (fast growing) for future woodlot or block plantation as it gives immediate return with easy cultivation. In questionnaire survey, 83% tree growers opined that plantation were damaged by cattle grazing/trampling, whereas 33% said that plantations were damaged by storm/cyclone. These two damaging factors were mainly responsible in their eyes for damage of plantation. Besides, 27% and 23% woodlot tree growers said that plantations were damaged by fuel wood collection or branch cutting and human interference respectively (Figure 2). Nevertheless, poultry or wildlife disturbance, flood hazards, insect or fungal attack also occur in woodlot plantation but negligible percentage. Woodlot plantation and maintenance is a labor-intensive work. Statements

ISSN 2278–5469 EISSN 2278–5450 I OPEN ACCESS

collected from the tree growers depicted that, out of total expenditure, more than 80% was used for seedlings purchase and labor hiring. The rest of the costs were goes under staking, fencing, manuring and transport of seedlings. In contrast, a minimum amount of budget was used for thinning, pruning and irrigation purposes. Pest attack in exotic woodlot plantation was negligible. Sometimes, plantation might be failed due to lack of care, protection, pest attack and natural calamities.

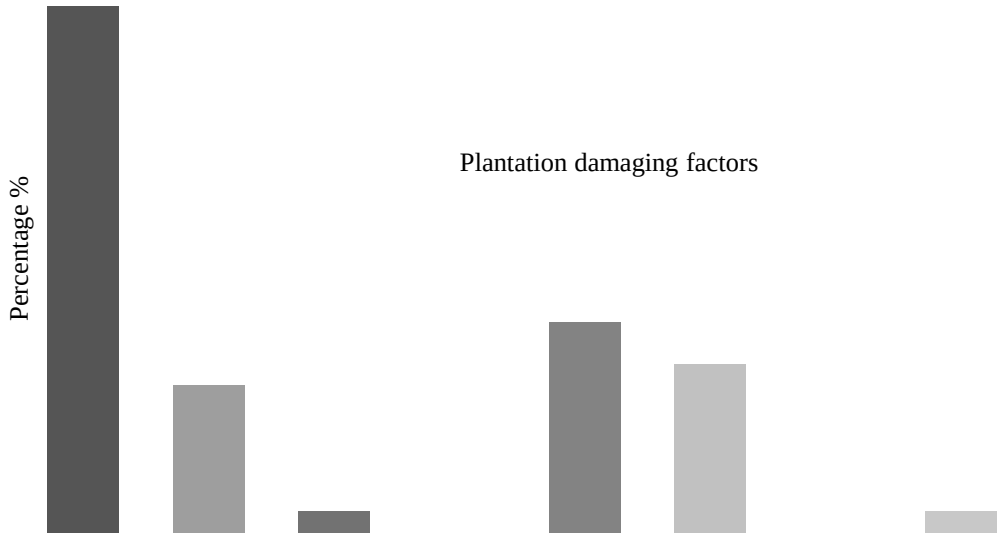

Figure 2. Tree growers perception (in percentage) on plantation damaging factors.

Proper maintenance of plantation (Silvicultural operation) such as fencing, weeding, cleaning, fertilizing, watering is required after planting of seedlings. Damage by the cattle cannot be avoided without continued fencing or physical presence at the plantation site. Nevertheless, over exploitation of plant resources, especially by illegal tree cutting, fuel wood collection, and cattle grazing etc. were observed as functioning in the exotic tree plots that could loss tree productivity, undergrowth species and genetic diversity. The undergrowth plant species especially that of monoculture plantation of exotic species, were known to be disturbed by biotic and abiotic factors. Among the biotic factors, clear felling, fuel wood collcetion, leaf litter collection, cattle grazing, firing, and making pathways for walking by the people etc. were mostly recognised by the respondents. The abiotic factors recognized in the study area includes shade, rainfall, temperature, soil moisture and humidity etc. Human intereferences, management initiatives, shade and wildness were recognized as the kye factors influencing the occurrence and existance of undergrowth species of the study area especially in the *Acacia* plots (Tyynela, 2001). The tree grower's principal objective of the woodlot establishment was to grow short rotation trees that will meet the demand of fuel, timber and access to more income but attitudes of tree growers toward tree farming issues may differ based on their objectives (Olowoyeye & Ajewole, 2020). The majority of the tree growers prefer to plant exotic timber species (fast growing) especially *Acacia* as it was delivering benefit with in very short period of time. It is assumed that, though the fast-growing exotic tree plantation contributing remarkable household income than indigenous slow growing tree species, but in the long run huge exotic tree plantation may create problems on existing natural resources, homestead forest biodiversity, ecosystems as well as indigenous Sal forests. It is analysed that, the tree productivity and economic return varies across land holding size, tending or cultural operation, education and technical know-how. It was observed the tree production in their own land depends significantly on species choice, land use pattern, topography, tending operation and the education level of tree grower etc.

Ideally village forests in Bangladesh comprised of a mixture of fruit, timber, medicinal and bamboo species but in Sakhipur, Tangail expansion of exotic species plantation either monoculture woodlot or other form is increasing than mix species cultivation, through which in future may reduce phytodiversity in this region. Tree plantation in the form of woodlot as well as agroforestry plantations provides year-round subsistence livelihood opportunities usually being fulfilled by forest products and NTFPs. It also provides a ground through which other livelihood objectives, such as gender equality through access to resources, income and employment, and sustainable use of resources, may be achieved. The major factors influencing the peoples towards exotic tree

ISSN 2278–5469 EISSN 2278–5450 I OPEN ACCESS

species plantation were: (i) increase in tree planting with the amount of land owned; (ii) farmers whose main source of income was non-agricultural were more likely to decide to plant trees in the homestead and farmland; (iii) purchase cost of fuel wood and scarcity of fuel wood; (iv) number of family member; and (v) knowledge of forestry extension activities.

The survey data showed that, 63% tree grower had received training on tree farming techniques and management in the study area, which is also reported by Das (2008). GOs and NGOs initiatives were found to improve the tree productivity through providing quality planting materials (e.g. seedlings, saplings) and technical support to the tree growers. Besides, a huge number of trainings was delivered to community people to raise tree nursery and improve tree cultivation techniques by the GOs and NGOs. Hocking *et al*. (1997) suggested that tree cultivation on village forest in over populated countries like Bangladesh can be diversified and intensified as well. Therefore, it is time to supplement the farmers' indigenous knowledge in tree cultivation with scientific knowledge. It is evident that, there had been a tremendous loss of native or indigenous tree species in many areas in the world due to monoculture planting of fast-growing exotic species like *Eucalyptus* (Zhang and Fu, 2009). In the survey few respondents depicted that, though the tree productivity of indigenous tree species provides less financial benefits than that of exotic tree species plots, but in the long run it is beneficial considering the negative impacts of exotic tree plantation. Paquette and Messier (2010) and Gravel and Meunier (2013) mentioned in a study that, exotic tree species plantation can affect biodiversity at the local scale though the increased wood production resulting from highly cared exotic plantations. Hooper *et al.* (2005), Felton *et al.* (2016) and Kibria and Anik (2010) claimed that, mixed-species plantation can provide positive outcomes relative to monocultures. In addition to cash benefits by the indigenous tree plantation offer other benefits, such as through supporting NTFPs of different medicinal and other economically important undergrowth species, fruits, higher number of wildlife with species diversity, carbon storage, phytodiversity along with rare and endangered species and healthy ecosystem (intangible benefit).

During the survey, it was observed that the aged or older persons from long experiences were not interested to form plantations of exotic species like *Acacia* and *Eucalyptus*, rather they were interested to plant indigenous species, e.g., Sal (*Shorea robusta)*, Jackfruit (*Artocarpus heterophyllus*), Mangifera (*Mangifera indica*), Jam (*Syzygium* spp.), Neem (*Azadirachta indica*), Chalta (*Dillenia indica*) etc. In contrary, field survey revealed that, *Acacia auriculiformis* was the most popular species by the local people, followed by *Eucalyptus camaldulensis* and *Swietenia macrophylla*. It was found that the two most frequently cited reasons why local people preferred *Acacia auriculiformis* over *Eucalyptus camaldulensis* and *Swietenia macrophylla* for their woodlot plantation were firstly that *Acacia* was the only tree species that produced small-dimension timber which is suitable for furniture making, timber grain direction and texture is similar with Teak (*Tectona grandis*) and secondly that they felt *Acacia* produced fuelwood of high fuel value (Kabir and Webb, 2005). It is quite apparent that, the social forestry program in Sal forest areas are far from ground level reality of social entrepreneurship and lacks long term planning wisdom for poverty alleviation and ecosystem management which is supported by the assessment done by Proshika (1998). Although the exotic tree species are sufficient for short-term use, but the long-term ecological and economic impacts are often over looked. Few of the respondents claimed that, the fast-growing exotic tree species (i.e., *Acacia, Eucalyptus*) have some negative impacts of shading on other smaller or shorter plants and they will compete for water and nutrients as it is a fast-growing species. But on the other hand, most of the respondents reported that, the growth performance of exotics, especially *Acacia*, was satisfactory so widely accepted by community peoples in Sakhipur areas of Tangail district.

Impacts on timber market and employment

In the study areas, the monoculture woodlot of exotic tree species showed a great impact on timber market and local employment. A total of 37 sawmills in Sakhipur Paorashava areas were found to be involved in woodlot business as well as timber trading in full swing. On the contrary, a number of 350 furniture making shops of different sizes were enlisted by furniture shops owners' association of Sakhipur. It was remarked that, about 90% of the timbers used by these shops were of *Acacia*. As the backup for theses shops, few thousands of peoples were engaged with tree felling/harvesting, wood and furniture transportation/carrying, timber sawing, furniture making and sale business. About 370 labors were employed in 37 sawmills and 1050 labors in 350 furniture shops in different positions for different period of time. Nevertheless, thousands of labors were hired in transportation/carrying of the timbers, furniture and fuel woods using hundreds of vehicles. Hundreds of *Faria* or local businessman was engaged with timber trading/business and marketing. Monoculture woodlot (fast growing exotic tree species plantation in a plot) had created income and employment flow in the study areas of Sakhipur, Tangail. For example, a total of 52 tree nurseries were found to involve 520 regular labors and more than 2,444 day labors were involved in 30 woodlot plantation activities in the private land. According to the tree grower's response, fuel woods from the Sal forest and adjacent village forest were in great demand in the cities (e.g. Dhaka, Gazipur, Tangail). Women and children were most active in collecting twigs, dry leaves and branches from the forest, while men were involved when they need to cut trees and to carry heavier bulks out of the forests. During this survey, 93% tree growers

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opined that, there were high demands of timber as well as fuel wood species in the local markets which were linked to meet the national demand and supply, and in contrast, only 7% tree growers opined that there were medium demands of timber as well as fuel wood species. It is also found that, 73% the woodlots plots had access to 'pacca' road and 37% to 'kancha' road to reach the markets for selling the timber products. All the participants suggested to improve the road network so that they can easily carry the woodlot products from the field. No remarkable problem was found in timber marketing, as reported by all the respondents. Tree growers had easy access to the local markets without the harassment by the middlemen who were taking the incentives for selling the trees. Sometimes middleman or *Faria* from Dhaka and other adjacent districts were used to visit the woodlots plots and if tree grower agreed then they harvest timber directly from the tree grower's woodlot plots (Figure 3). About 40% tree growers directly sold timber/fuel wood products to local market by their own initiatives and 60% tree grower were sold timber/fuel wood products through middleman or *Faria*.

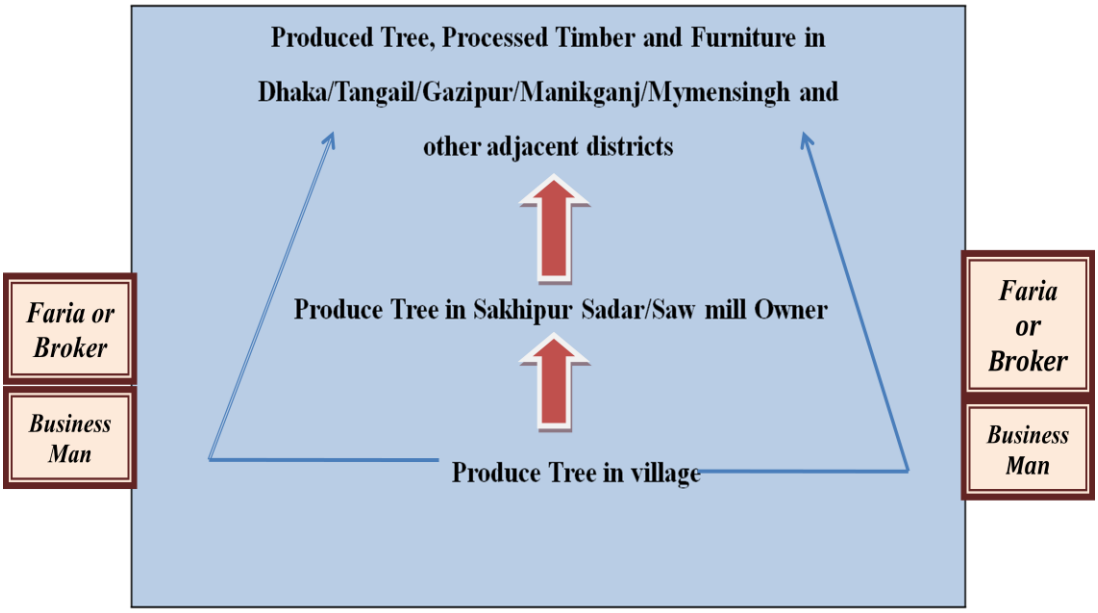

Figure 3. Timber supply chain in the study area

The survey in the saw mill and furniture making shop revealed that, *Acacia* timber was more valuable due to its grain direction and finishing like Teak (*Tectona grandis*) timber. Therefore, the value and market demand of *Acacia* was more than that of *Eucalyptus.* Tree growers usually sale their produced standing trees at the gate of their farms instead of secondary markets or saw mill gates to avoid felling and carrying cost and harass by the middlemen in some cases, though they get comparatively lower prices than that at secondary markets or saw mill gates. The tree growers as well as farmers found the job as agricultural labors only during peak agricultural crop seasons and remain jobless for the rest several months of the year. Wood and NTFPs production in their fields can save them from poverty in such a way that it will provide them some supporting and intermediate returns before harvesting of trees. This study depicted that, few thousands of people were enagaged with tree nurseries, tree felling/harvesting, wood and furniture transportation/carrying, timber sawing, furniture making and wood/timber business and marketing. These sort of business market and supply chains, directly accelerated the local economy in Sakhipur, which is exceptional example in Bangladesh. This statement is supported by the study done by Sedjo (1999), FAO (2010), Dodet and Collet (2012) and Anderson et al. (2015). In contrary, the establishment of wood based small industries, furniture shops and traditional brick-burning kilns in the close vicinity of forests, established through political influence and power exercise, were creating pressure on forest resources in Sakhipur, Tangail. During the survey, most of the tree growers opined that, there were high demands of timber as well as fuel wood species in the local and national level market including that of the capital city Dhaka. Though the tree growers (respondents) were apparently unaware about any good quality of indigenous tree species in relation to biodiversity conservation but they could recognize the exotic trees as economically viable species due to their fast growing characteristics and increasing market demand, especially for timber for furniture making. ESRU (1992) reported that, *Shorea* poles and sawn timbers are used in house building, piling as it is heavy hardwood and these poles have an unlimited market demand across the country especially in the capital city Dhaka. But its only one problem is that, it is relatively very slow growing species in respect to *Acacia* or *Eucalyptus*.

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Perception of the tree growers

As a part of questionnaire survey, a number of questions were asked to the respondents to know their perception on the cultivation of exotic tree species (i.e. monoculture woodlot) in order to know the benefit and losses from the woodlot plantation programme. The tree growers' opinions on the loss and benefits derived from monocultures were found to be different in term of loss and benefit categories which is derived from questionnaire survey (Figure 4). In this connection, 93%, 97%, 87% and 77%, *i.e*. most of the tree growers, mentioned that exotic monoculture gives benefits for fuel wood, pole/post, wind break/shelter belt and fencing/boundary respectively and on the other hand 67% and 47% of the tree growers thought that monoculture plantation of exotic species produce scenic beauty and somehow support for bird nest and roosting respectively (Figure 4). The results of statistical analysis showed that, only 7% of the respondents showed their negative attitude for woodlot production of exotic tree species in their own land concerning financial benefits. Most of the respondents (tree growers) mentioned that, the forests trees are the prime source of their energy/household consumption through collection of firewood, dry leaves and branches etc, and even they use the dried climbers and leaves as fuel. People living in the areas adjacent to the forests, collect small twigs, chips of bark, branches, and decayed branches as firewood for their household consumption and for selling in the markets. Overall analyses of environmental as well as ecological aspects on monoculture of exotic species plantation revealed that, 30% respondents had showed positive attitude for monoculture of exotic tree species in their field and the rest 70% showed negative attitude. About 63% tree growers received training on community/social forestry, and tree farming techniques and management from GO/NGO. The results of questionnaire survey conducted under this study showed that, in respect to participating farmers and from socio-economic aspects, 93% respondents had showed their positive attitude for exotic tree species grown up in the field and the rest 7% showed negative attitude. Most of the tree growers did not bother for the adverse effect of exotic trees, as they believed that the profit from the trees was more than the loss (Figure 4). In contrary Islam (2006) examined the ongoing social forestry programs by the government in the central part of Bangladesh and he found that such kind of plantation programs are not well accepted by most of the local people.

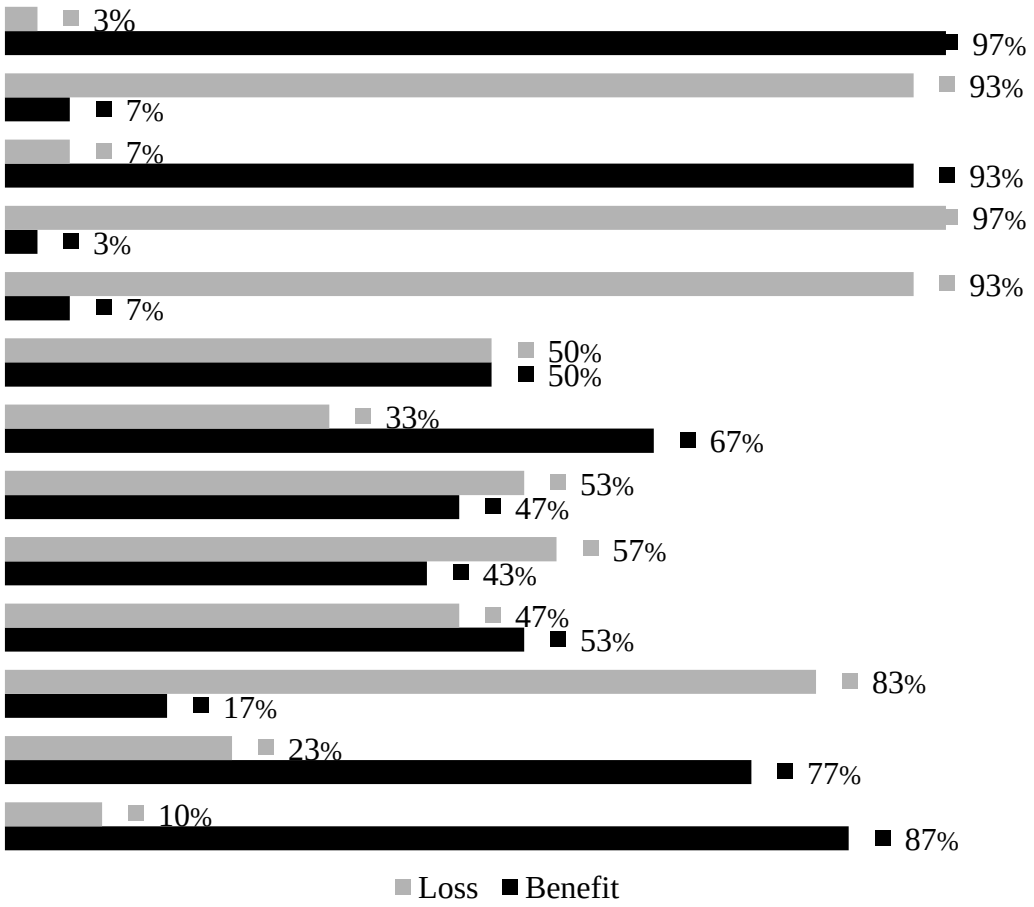

Figure 4. Private woodlot tree growers' perception on losses and benefits derived from monoculture woodlot plantations.

During this study, both the positive socio-economic impacts and negative environmental (ecological) impacts of the monoculture plantation with exotic tree species were found. However, during the survey most of the farmers were found enthusiastic to raise monoculture plantations of exotic tree species even in their agricultural lands. The most important aspect was that, monoculture plantation, mixed plantation or agroforestry practices whatever they are offered, in each case the ultimate goal or demand was the quick return from the plantation with low investment. Though people were practicing all of these but they have some extra eagerness in woodlot plantations as well as agroforestry. The existing tree growers were expecting that, most of the farmers might go for woodlot block plantation in practice in the near future leaving regular agricultural practices. Local peoples were also interested to cultivate exotic timber species with fast growing nature as it is meeting their immediate demand within a short period of time. Tree growers were interested in preferring the fast-growing tree species, especially *Acacia* for future woodlot block plantation due to its wide range of adaptive capacity and excellent timber and fuel wood productivity, supported by NAS (1980), Akkasaeng *et al.* (1989), Duguma and Tonye (1994), Kamara and Maghembe (1994), Rahman (2003), Kabir and Webb (2005) and Das (2008).

The tree growers were in search for alternative ways for improving their livelihood and most of the farmers expected that, the concept of plantation might be way to complement their family income greatly and in short time if they go forward to fast growing exotic tree production and selling the timber to the market. Many of them will construct new houses and manufactured household furniture through selling trees in the coming days. Tree selling will not only meet their cash requirement but also for education, marriage, treatment, festivals and even land purchase. The farmers thought that, who have trees at a harvestable age, perceive trees as their social insurance and bank balance as well. Selling trees became the most common strategy for the tree grower farmer to cope up the difficulties of their existing livelihood. Whenever they felt need cash for health treatment, dowry, festivals, repairing or construction of new houses, trees will be sold accordingly. Keeping in mind woodlot plantation forests have been established as even-aged monoculture crops of trees with the primary purpose of wood production (Evans, 1996). Most of the respondent (tree growers) opined that, the abandoned or unused land of the homesteads, where water logging exists for long time and which is not so fertile, are used for fast growing exotic tree plantation as it is not so harmful and they are growing well with wide adaptive capacity. Moreover, agricultural land (farm land) is used for woodlot plantation as it is less troublesome than agricultural crops production. Among all other exotic species available in Bangladesh, *Acacia auriculiformis* were found highly adaptable and fast-growing tree species to withstand even in the degraded site conditions and in a wide range of soils under different conditions (NAS, 1980; Akkasaeng *et al*., 1989; Duguma and Tonye, 1994; Kamara and Maghembe, 1994). The most common benefit that was conveyed by tree grower households was social development through achieving income and employment. Hence, it can be implied that there is an expectation in the community that investments in forestry production will encourage social development in the way of better health care, education, household infrastructure improvement and insurance etc. and this statement is supported by the study of Tschirley and Benfica (2001). In contrary it is revealed that, the woodlot plantation activities were imposed by BFD on the local people and BFD did not bother to explain the objectives and by the name of increasing the tree coverage BFD destroyed valuable natural Sal (*Shorea*) forests in order to raise the woodlot forestry (Gain, 1998). It is marked that government has cleared natural Sal (*Shorea robusta*) forests to make plantation space for this forestry programs that ultimately causes forest degradation and deforestation. Unsuitable execution of exotic tree species plantations programs without consulting with the local stakeholders (i.e. woodlot plantation or agroforestry in the national park and/or eco-park projects) may mislead the government authorities to act against the sustenance of the natural forests (Islam, 2006). On the other hand, the move of the majority of the farmers from agricultural practices into woodlot forestry (block plantations) might create shortage of agricultural land resulting remarkably less production of staple foods which is also not supported by the LULUCF strategy of UNFCCC. The NGOs have added a new dimension to forest management, which has ensured community participation and protection of the forests (Safa, 2006). Through the involvement in social forestry programs, nursery developments and tree plantation campaign, environmental awareness building, etc the NGOs are actively supporting local people in afforestation activities. But it was found during the survey that, the role of the NGOs in protecting natural forest and forest related activities were not enough and satisfactory. However, field survey and observation were found to be useful tools in collecting information about socio-economic and environmental parameters through interviewing local people, businessman, government officials, NGOs, activists, and politicians.

Monoculture of exotic species (i.e. woodlots plots) usually offer harbor less number of wildlife than indigenous tree plots that might be due to the absence of fruits, insects, bush, undergrowth, creepers and human interferences and this statement is supported by Elmarsdottir *et al.* (2008) and Proshika (2000). During the data collection in the exotic woodlots, only a few numbers of local resident birds e.g. common myna (*Acridotheres tristis*), oriental magpie-robin (*Copsychus saularis*), jungle babbler (*Turdoides striata*), black drongo (*Dicrurus macrocercus*) and three striped palm squirrel (*Funambulus palmarum*), reptiles, insects were observed. Accordingly, most of the respondents opined that, wildlife of the study area has been decreased due to exotic tree plantation

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activities, whereas a few of them disagreed with the opinion. Most of the tree growers opined that, exotic monoculture tree plantations have been found to be poor habitat for resident wildlife and birds due to absence of fruits and insects. Bird species that mostly feed on fruits and nectar, and those that nest in holes of tree trunk or are insectivorous were almost absent in exotic monoculture plantation sites. Old, dead and moribund trees that support bird life and many insects were completely absent in exotic tree plots/stands. Thus, the findings of this study suggested for emphasizing the mixed plantation programs with both indigenous and exotic species to favor biodiversity conservation and demand of the local people long run it is beneficial considering the negative impacts of exotic tree plantation supported by Felton *et al.* (2016) and Kibria and Anik (2010). Moreover, the community based natural resource management of the Sal forest would be the most viable option to promote ecological and economic stability at community level and this statement is supported by the study done by Adhikari *et al.* (2004). Managing forests at private and public level should be with such aims that it will earn money, save the land from encroachment, ensure a scope of employment and income generation, and be a model of sustainable land use management practice in Bangladesh (Alam *et al*., 2008).

4. CONCLUSIONS

The outcomes of this study suggested that, diversity of tree species and extension of education amongst tree growers would improve community forest production, ecosystem as well as socio-economic development. Woodlot production of fast growing exotic tree species has short term financial impacts on the rural economy and social development. But cultivation of exotic tree species (i.e. monoculture woodlot plots) seem fails to ensure the sustainability of healthy ecosystem, and therefore, be discouraged for massive afforestation programs. Considering the increasing demand of the growing population and interest of the tree growers, the exotic tree species plantation by the name of monoculture woodlot of can be considered in abandoned, unused, degraded, fallow, less fertile or specified lands or for limited and site-specific plantation only until the introduction of the fast growing indigenous tree species and confirmation of alternative sources of income. Government strategies and policies on the introduction and plantation of exotic species for timber and fuel wood production need to be revised based on ecological and socio-economic insights. Experiments on mixed tree cropping for timber production with short rotation of agroforestry products, such as nuts, fruits, honey, herbs, firewood should be conducted. Adequate awareness building programmes to increase the understanding of the vulnerability of the environment, climate change adaptation and mitigation, the importance of indigenous 'Sal' forest conservation management and homestead forest biodiversity should be implemented. The fast growing exotic tree production has direct and short term positive financial impacts on the local economy and social development of the beneficiaries as well as in local community level, but also have negative impact from the environmental or ecological perspective.

Acknowledgments

The authors thank to BFD and Proshika for supporting to gather information from the study area.

Funding

This study has not received any external funding.

Conflicts of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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