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AN ASSESSMENT OF PRIVATE WOODLOT AT KALIGONJ UPAZILLA OF JHENAIDAH DISTRICT, BANGLADESH

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Abstract

The study presents an assessment of the species selection, management technique, and socio-economic benefits of raising private woodlot plantations in Kaligonja upazila, Jhenaidah district of Bangladesh during 2016-2017. A total of 80 woodlot owners were surveyed randomly to assess the status of woodlot plantations. Major growers (55%) were middle-aged (41-55 years) and dominated by males (95%). About 90% of woodlots were rectangular in size and monoculture in species composition (70%) of which about 75% was *Swietenia macrophylla*. A total of 77.5% of owners has single ownership, whereas about 97.5% of the respondents practice woodlot on their landowner. The majority of the land (85%) was previously used as agricultural landowner. The socioeconomic benefit was timber production, utilization of fallow land, income generation, fuel wood production, etc. The owners manage their woodlots by following traditional and silvicultural techniques. Most of the respondents are conscious and have general knowledge of thinning (80%) and pruning (97.5%). Selection felling systems (60%) and clear felling (40%) were the two types of harvesting systems found in this area. About 90% of respondents fixed the rotation period ranging from 10 to 20 years depending on the species and market value. They still need proper guidance and training to increase their knowledge and efficiency for the maximum productivity of woodlots in the study area.

Keywords: Harvest, Monoculture, Ownership, Rotation, Woodlot shape,Woodlot size

Introduction

The area of forestland in Bangladesh is 2.6 million ha (17.62% of the country's entire area) (FD, 2016). Bangladesh Forest Department (BFD) manages 1.6 million hectares of forestland (FD, 2016). Only 6.7% of the total area of Bangladesh is forested and that area is being exhausted at the distressing rate of 3.1% per annum (FAO, 2009). Forests in tropical countries like Bangladesh are fading at a frightening frequency because of various socio-economic extortions, biotic forces, and competing land uses. Additional causes of forest degradation include encroachment, grazing, fire, uncontrolled and wasteful commercial logging, illegal felling, fuel wood collection, and official transfer of forestland to another sector, i.e., for settlement, agriculture, and other industries (Anon, 2011).

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The area of Bangladesh is very small and incomparable to the population. The increasing number of people creates new pressure on the various inadequate resources like forest and land resources (FAO, 2015). Humans also transfigure forestland into agricultural land and for other purposes that cause the annihilation of forests and the degradation of the environment. There is no scope to increase the forestland and agricultural land, but the production will be increased by converting the traditional land use pattern into sustainable land uses like agroforestry and woodlot plantation (Nair, 2006). The number of private woodlots should be increased to reduce the pressure on a natural forest to fulfill forest-related needs. It provides a notable contribution to sustainable agricultural production because of its potential to meet economic, social, ecological, and institutional conditions for sustainable livelihoods (Nair, 2006). It also provides alternative sustainable sources of fresh resources for woody industries (Aggangan, 2003) and recovers the microclimate circumstance of the area, and lessens soil erosion and siltation of rivers and streams.

At present, woodlot is an accepted sustainable enlargement prototype throughout the world. In Bangladesh, it is defined as the deliberate growing and tending of fast-growing tree species on state/privately owned land for locally used fuel wood, poles, posts, and small wood for local consumption and cottage industries (BBS, 2014). Woodlot has been raised as a benefit-sharing program with the involvement of land encroachers and other economically disadvantaged people (Muhammed *et al*., 2008). Kaligonj Upazila in Jhenaidah district is an important area of Bangladesh, where the practice of agroforestry and woodlots are more extensive and the area is suitable for these practices. But, the status of a woodlot (like woodlot's size and shape, cost and benefits, management technique, land ownership, etc.) is still unknown in this area. Bangladesh needs to increase the number of private woodlots to conserve the environment as well as uplift the livelihood of marginal. At the same time, the appropriate management technique is the primary provider for economic paybacks. Considering all of these, this study aims to obtain the present management status and socio-economic benefits of a private woodlot.

Materials and Methods

Study area

Kaliganj Upazila of Jhenaidah district, located in southwestern Bangladesh, with an area of 303.53 sq. km, is located between 23°16´ and 23°28´ north latitudes and in between 89°02´ and 89°16´ east longitudes (Fig-1). It is bounded by Jhenaidah Sadar Upazila on the north, Jessore Sadar and Chaugachha Upazila on the south, Salikha and Bagherpara Upazilas on the east, Kotchandpur and Chaugachha Upazila on the west. About 63.46% are landowners and 36.54% are landless. The main crops are paddy, jute, sugarcane, betel leaf, wheat, pulse, and vegetables. The main rivers are Chitra, Bhairab, and Begabati. The main baors are Morjat, Sarjat, Sako, Barfa and Simla Baor. Noted beels are Uttar (Magura - Tattipur), Dighar, Arua Salva and Tentul Beel. The duration of the rainy season is June to

October followed by winter (November to February) and the dry season (March to May) (BES. 2020). The annual average temperature varies from a maximum of 36.6°C to a minimum of 12.8°C and the average annual rainfall is 1492 mm (BES. 2020).

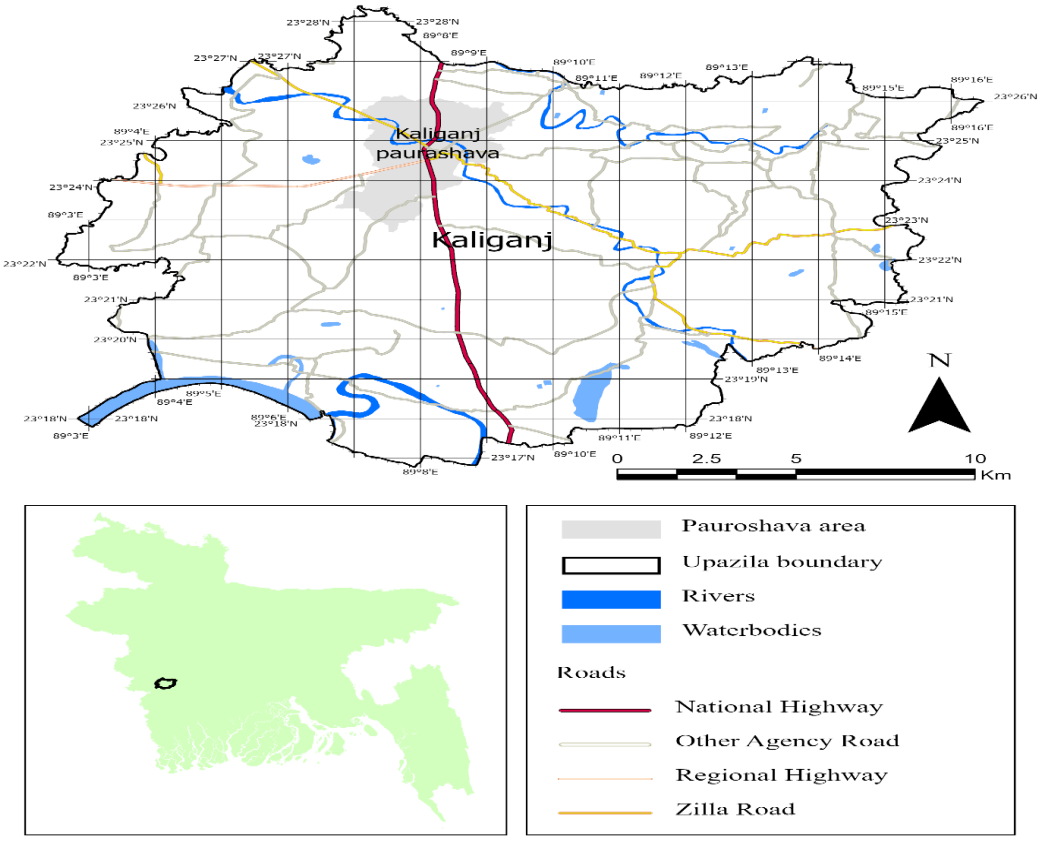

Fig 1. Map of Kaligonj Upazila, Jhenaidah

Methodology

An exploratory survey was conducted by a multistage random sampling technique in Kaliganj upazila, Jhenaidah purposively during 2016-2017. The criterion for selecting the site was the availability and diversity of private woodlot plantations. At first, a reconnaissance survey was carried out to select the potential village. Ten potential villages were selected purposively where many woodlots were located. After that, eight respondents from each village were selected randomly and a total of 80 respondents were contacted to participate in the face-to-face interview. Demographic (such as age, gender, income, land ownership, occupation, etc.) and management data on this aspect were collected by interviewing the respondents by questionnaire and by the author's observation. All data were compiled and the descriptive analysis was done by Microsoft Office Excel 2019.

Results

Socio-economic characteristics of the respondents

In the study area, during 2016-2017, most of the woodlot owners were educated (89%), economically podded, and had another source of income other than agriculture. About 32% of woodlot owners completed Secondary School Certificate (SSC) followed by below SSC (15%), Higher Secondary School Certificate (HSC) (28%), graduation (14%), and illiterate (11%) (Table 1). The age of the respondents in the study area was divided into three categories. Major respondents (55%) were middle-aged (41-55 years old) followed by 25% were 25-40 years and 20% were 56-70 years (Table 1). About 95% were male and only 5% were female. Professionally they were farmers (49%), businessmen (31%), and service holders (20%) (Table 1). They were categorized into five groups based on their income. The highest (35%) woodlot owner earned (yearly) between 80001.-130000 taka followed by 30000 -80000 taka (5%), 130001 - 180000 taka (30%), 180001 -230000 taka (22%) and 8% earn more than 230000 taka (Table 1).

Table 1. Demographic status (age, gender, education, occupation, and income) of the respondents (N=80)

Age		**Occupation**	
Categories	Percentage %	Categories	Percentage %
25-40 years	25	Farmer	49
41-55 years	55	Business	31
56-70 years	20	Service Holder	20
Gender		**Yearly Income**	
Categories	Percentage %	Earnings	Percentage %
Male	95	30000-80000 taka	5
Female	5	80001-130000 taka	35
Education		130001-180000 taka	30
Categories	Percentage %	180001-230000 taka	22
Below SSC	15	More than 230000 taka	8
SSC	32		
HSC	28		
Graduate	14		
Illiterate	11		

A complete portrayal of the woodlot in the study area

About 90% of the woodlots were rectangular, and 10% were irregular where 77.5% of woodlots had single ownership and the rest 22.5% had joint ownership. About 97.5% of woodlots were on their land and only 2.5% practiced on leased land (Table 2). Most of the

Table 2. Shape, land used pattern, type of species and plantation, landholdings and ownership, and benefits of woodlot in the study area.

Shape of the woodlot		**Woodlot land used previously**	
Categories	Percentage	Categories	Percentage
Rectangular	90%	Fallow	10%
Irregular	10%	Agriculture	85%
		Others	5%
Types of species			
Categories		**Type of the plantation**	
	Percentage	Categories	Percentage
Mahagony	75%	Mono-plantation	70%
Other	25%	Mixed-plantation	30%
Landholdings		**Ownership**	
Categories	Percentage	Categories	Percentage
Own	97.50%	Jointly	22.50%
Leased	2.50%	Single	77.50%
Sources of the planting materials		**Types of the seedlings**	
Categories	Percentage	Categories	Percentage
Purchase	92.50%	Taproot	80%
Own raised	5%	Polybag	18.75%
Others	2.50%	Seed sowing	1.25%
Age of the seedlings		**Purposes**	
Categories	Percentage	Categories	Percentage
1 year	46.25%	Easily manageable	20%
2 years	42.75%	Economically Profitable	40%
above 2 years	10%	Safe investment	5%
Benefits		Security	2.50%
Categories	Percentage	Unfit for agriculture	32.50%
Cash	75%		
Timber	10%		
Others	15%		

land was previously used as agricultural land (85%) where 10% of fallow land and the rest was other uses (5%). Within 5%, the lands were used as a brickfield, poultry farm, homestead land, and woodlot also. The increased price of agricultural inputs like fertilizer, seed, etc., was the leading cause of raising woodlots in agricultural land. Most

of the respondents converted their agricultural land into woodlot when the land lost its fertility and suitability for agricultural crop production. The shortage of time for care and protection of agricultural fields was also a cause of raising woodlots in agricultural land. Planting materials used by the respondents were mostly purchased from nurseries (92.5%). About 5% used their seedlings and only 2.5% took free from the government or NGOs (Table 2). Most of the respondents (80%) used coppice followed by polybag seedlings (18.75%) and sown seeds (1.25%) in the woodlot areas. It was found that 46.25% of the respondents used 1-year-old seedlings whereas 43.75% and 10% of respondents used 2 years old and more than 2 years old seedlings respectively (Table 2). All respondents planted the seedlings in the rainy season (June-August). About 40% of respondents raised woodlot for economic profit (i.e. low investment, low maintenance cost, more profit at a time, etc.) while 32.5% for the utilization of fallow agricultural land. Another 20% practiced woodlot for easy management technique and require less time and manpower, 5% for a safe investment, and 2.5% for security for the solvency of the new generation and to keep possessions of the land (Table 2). Maximum respondents (75%) thought that income generation was the most important benefit obtained by selling timber, fuel wood, and fruits. Some respondents (10%) used timber for household construction, furniture, etc., and the other 15% of respondents mentioned other benefits of woodlot.

Maximum (70%) woodlots in the study area were mono plantations and only 30% were mixed plantations (Table 2). Within the monoculture, about 75% was comprised of *Swietenia macrophylla*. Other 25% of plantations were comprised of *Samanea saman*, *Leucaena leucocephala*, *Dalbergia sissoo*, etc. (Table 3). In a mixed plantation, a number of species used such as *Swietenia macrophylla*, *Samanea saman*, *Leucaena leucocephala*, *Dalbergia sissoo*, *Azadirachta indica*, *Gmelina arborea*, *Bombax ceiba*, *Syzygium cumini*, *Albizia procera*, *Artocarpus heterophyllus*, *Acacia nilotica*, etc., (Table 3). It was found that most of the private woodlot comprised *Swietenia macrophylla* because of its good growth, timber quality, and demand. Now, respondents disagreed to raise *Leucaena leucocephala* plantation because of its light timber and because it was easily damaged by the storm. So, *Leucaena leucocephala* was found in some old woodlots of the study area but no new plantation was established with *Leucaena leucocephala*. Next to *Swietenia macrophylla*, respondents' prefers to plant *Dalbergia sissoo*, *Samanea saman*, and *Albizia procera* and few choose to plant *Acacia nilotica*, *Syzygium cumini*, *Neolamarckia cadamba*, *Azadirachta indica*, etc., (Table 3). It was also found that some respondents practiced agricultural crops simultaneously like *Curcuma longa*, *Zingiber officinale*, *Solanum melongena*, *Colocasia esculenta*, *Citrus aurantifolia*, etc. They practiced these crops, mostly in the initial years of the establishment of the woodlots.

Table 3. Tree species found in the woodlot at Kaliganj Upazilla of Jhenaidah district

	Tree species		
Local name	Scientific name	Local name	Scientific name
Mahogoni	*Swietenia macrophylla*	Kathal	*Artocarpus heterophyllus*
Raintree	*Samanea saman*	Jam	*Syzygium cumini*
Koroi	*Albizia procera*	Aam	*Mangifera indica*
Ipil-ipil	*Leucaena leucocephala*	**Agricultural crops**	
Sissoo	*Dalbergia sissoo*	Halud	*Curcuma longa*
Kadam	*Neolamarckia cadamba*	Kachu	*Colocasia esculenta*
Neem	*Azadirachta indica*	Ginger	*Zingiber officinale*
Babla	*Acacia nilotica*	Lebu	*Citrus aurantifolia*
Simul	*Bombax ceiba*	Brinjal	*Solanum melongena*
Gamari	*Gmelina arborea*		

Other benefits

Species like *Leucana leucocephala*, *Anthocephalus chinensis*, *Acacia nilotica* etc. were raised mainly for producing and selling fuel wood. Branches pruned from trees, dry leaves, dry branches, and trees that were removed by thinning or other cutting were also used as good fuel. *Syzygium cumini*, *Citrus aurantifolia*, *Artocarpus heterophyllus*, *Mangifera indica*, etc., were very nutritious fruits that fulfilled the demand of local people. These types of fruit-producing trees were grown purposively. Some woodlot plantations were considered a money-saving account for present and future generations. They thought that woodlots will provide a handsome amount of money at a time. Some tree species had medicinal value and varieties of products were made from a grown tree on the woodlot. Palatable and nutritious fodder was also grown in woodlots like *Acacia nilotica*, *Leucana leucocephala*, etc. The wasteland and degraded land were properly utilized by planting trees. Most of the forestry activities are labor-intensive so woodlot plantations increased the employment opportunity. In the middle of the agricultural land sometimes woodlots were made to break the wind flow. Woodlots helped to improve the environmental condition by giving oxygen and taking CO_2. It reduced soil erosion, increased nutrients of soil through litter fall, reduced temperature, etc.

Management technique of the woodlot

Site preparation

The total respondents (100%) reported that they took extra care of soil like plowing, digging, etc. but no burning was done at all just before planting the seedlings. Soil work was done for minimizing soil loss. Spacing is very essential for tree growth,

especially for tree diameter and height. In the study area, the maximum number of respondents (70%) planted trees with 1.83m × 1.83m distance followed by 1.98m × 1.98m (16.25%) and 2.13m × 2.13m (13.75%) distance (Table 4).

Tending operation

Weeding was generally done in the seedling stage of the plantation. In the study area, 100% of the respondents practiced weeding to ensure rapid growth and reduce competition for light and nutrition. Most respondents said that they practiced weeding in the early years of the establishment of the woodlot. About 80% of respondents practiced 2 times weeding per annum and the other 20% practiced 1 time per annum (Table 4). Cleaning was done to free the best trees from undesirable individuals of the same age that overtop them or are likely to do so. In the study area, 95% of the respondents have practiced cleaning and the other 5% of respondents did not practice (Table 4). Most of the respondents (about 80%) were conscious and practiced thinning and the rest of the respondents (20%) did not practice thinning at all (Table 4). Some respondents felled the vigorous trees during thinning for giving better opportunities to the trees of slower growth. The majority (97.5%) of the respondents in the study area practiced pruning and only 2.5% were not practiced. The wrong pruning operation may produce a defect in the tree and reduce timber quality.

Improvement of the site

About 98.75% of the respondents used various types of fertilizers (Triple Super Phosphate, potash, urea, cow dung, etc.) in their woodlot to improve the growing conditions before planting trees. They usually used 50 kg TSP or potash or urea per bigha (1 bigha = 33 decimals). Other 1.25 % of respondents did not use fertilizers. Only 15% of the respondents watered the woodlot whereas 85% were not practiced. It was done during the dry season when the soil became very dry due to excessive water evaporation of water from the soil by shallow and deep tube-well.

Woodlot maintenance

A total of the respondents (100%) took special protection to save their woodlot in the initial stage from cattle, human beings, insects, etc. They built bamboo and *Acacia nilotica* live fences to protect their woodlot from grazing animals and human interference. They sprayed pesticides such as Malathion, Thiovit, Karati, etc. protect their woodlot from different pests and insects. They used different types of sticks to provide support to the young seedlings. About 52.5% of the respondents have filled the vacant area produced by the death of seedlings (Table 4). Most of them followed vacancy filling after one year of plantation. The rest respondents (47.5%) did not practice vacancy filling.

Harvesting and rotation

About 60% of the respondents harvested their woodlot by selection system. Another 40% used a clear-felling system. In the case of rotation, most of the respondents (90%) did not fix the rotation and only 10% fixed the rotation year 10-20 years which varied with species. For *Leucana leucocephala* and *Neolamarckia cadamba* they fixed 10 years but for *Swietenia macrophylla*, *Acacia nilotica*, *Dalbergia sissoo*, *Samanea saman*,

Azadirachta indica, *Albizia procera*, *Albizia lebbeck*, etc. they fixed 20 years or more. Because *Leucana leucocephala* and *Anthocephalus chinensis plantations* were raised for fuelwood purposes but others were planted for timber production. In the case of fruit species, rotation age was not fixed.

Table 4. Respondents' attitude on spacing, site preparation, site improvement, rotation, protection, tending, and harvesting of woodlot in the study area.

					Yes	No
Spacing	Categories	Percentage	Site preparation	Soil Working	100%	0%
	1.83m x 1.83m	70%		Burning	0%	100%
	1.98 m x 1.98 m	16.25%	Tending operation	Weeding	100%	0%
	2.13 m x 2.13 m	13.75%		Cleaning	95%	5%
Harvesting	Categories	Percentage		Thinning	80%	20%
	Clear felling	40%		Pruning	97.5%	2.5%
	Selection system	60%	Improvement of the site	Fertilizing	98.5%	1.25%
Rotation age	Categories	Percentage		Watering	15%	85%
	10-20 years	10%	Woodlot maintenance	Protection	100%	0%
	Not Fixed	90%		Vacancy filling	52.5%	47.5%

Problems of woodlot

The major problem in the study area was grazing because of having pet animals. Respondents said that seedlings and trees were damaged by cattle with insect and pest attacks. All owners did not practice thinning, pruning, salvage cutting, sanitation cutting, etc., at the right time. Some people did not use accurate techniques and tools for pruning at the correct time as a result timber quality had been damaged. Besides this, the lack of a proper supply of planting material at a reasonable price locally and the unconsciousness of respondents about rotation reduced the production also. In some cases, owners did not agree to use fast-growing locally suitable species. Successful woodlot plantations were affected by the unwillingness to vacancy filling caused by the lack of proper training and guideline of the respondents.

Discussion

The biographical characteristics (age, education, and source of income) and the socio-economic characteristics had much influence on the adoption behavior regarding new practices (Amacher *et al*., 2004; Hansen *et al*., 2005; Salam *et al*., 2000). Mostly middle-aged (55%) and male (95%) people in the study area were practicing woodlot more because they decide for their families. One of the major demographic characteristics was the age that influences the adoption of agroforestry (Buyinza and Wambede, 2008, Gebreegziabher *et al*., 2008, Kabwe *et al*., 2009, Neupane *et al*., 2002). Traditionally middle-aged males are responsible for agricultural and forestry works that

retard females to join such activities in Bangladesh (Azad *et al*., 2020; Bichitra *et al*., 2022; Dey *et al*., 2020; Islam *et al*., 2020; Nurunnahar *et al*., 2020; Ripon *et al*., 2021). In the study area, the educated people (about 89%) who had another source of income and had available land for woodlot plantations practiced woodlots as an extra income source. Besides, educated people were more conscious of the importance of woodlots. It was found that the people who had economic solvency raised woodlot because woodlot is a long-term investment. Economic factors were more important than ecological factors in shaping farmers' decisions (Salam et al., 2000). In contrast to the outcomes of Emtage and Suh (2004) from the Philippines, where decisions were driven by the household needs for timber and building materials. However, the main purpose of raising woodlots in the study area was economic profit (40%). Most of the owners said that the practice of woodlot was not their main occupation. But they established it because they had not enough time to cultivate crops. It seemed that about 85% of agricultural land was converted into woodlot in this area. Larger-income households accepted new technologies more and a similar result was found in many studies around the world (Patel *et al*., 1995; Hyde *et al*., 2000; Pattanayak *et al*., 2003).

Moreover, it was found that 77.5% had single ownership, and the rest 22.5% had joint ownership where 97.5% practiced woodlot on their land and only 2.5% practiced on leased land. Joint ownership means a single woodlot has more than one owner. The major reason for ownership jointly of the woodlot was joint ownership of land acquired hereditarily in Bangladesh. Most owners practiced woodlot on their land because the tree has long rotation than crops and in the case of own lands it is secured, but in the case of leased land, it is not secured. (Nyadzi *et al*., 2003) reasoned that farmers with land deficiencies did not have sufficient land to exercise agroforestry like woodlot. Maximum (70%) woodlots in the study area were mono plantations and only 30% were mixed plantations. Rahaman *et al*., (2020) stated that mono-culture adjacent to natural forests declines the diversity with having high carbon accumulation value (Pitol and Mian, 2022; Pitol *et al*., 2019), but the study area was far from the natural forest land. Most of the activities were labor-intensive and increased employment opportunities. Besides, many authors (Dev *et al*., 2006; Appiah and Pappinen, 2010; Stewart *et al*., 2011) informed that woodlots offer both environmental and social benefits like give oxygen (O_2) and taking CO_2, used as a windbreak, reducing soil erosion, increased nutrients of soil through litterfall, reduced temperature, etc. About 75% comprised of *Swietenia macrophylla* and Pitol *et al*., (2019) stated that the woodlot plantation of *Swietenia macrophylla* at Kaliganj Upazila absorbed a huge amount of carbon (168.99 Mg ha-1). While *Swietenia macrophylla* woodlot uptook 125.5-1004.5 Mg/ha (mean 436.3 Mg/ha) of CO_2 and released 91.25-730.26 Mg/ha (mean 317.2 Mg/ha) of oxygen (O_2) that may earn 4,285-34,470 BDT/ha (mean 14,900 BDT/ha) and 3.2-25.5 million BDT/ha (average 11.1million BDT/ha) respectively (Pitol and Mian, 2022). Woodlot in the study area was maintained and advancement work was done by the owner. It seemed that 100% took special protection for their woodlot whereas 98.5% applied fertilizer. They knew weeding (100%), cleaning (95%), thinning (80%), and pruning (97.5%), but only 52.50% filled the vacant area caused by the death of trees. They still need proper guidance and training that will increase their knowledge and provide aid for the advancement of woodlots in the study area.

Recommendation

Protection against cattle should be taken properly and it will reduce the causes of seedlings and tree damage. The planting materials should be raised locally and potentially near the woodlots which will ensure a good supply of planting materials at a reasonable price. Proper pest management should be done at the right time and it will reduce the risk of total tree attack. After any natural disaster removal of uprooted and pruning of damaged branches should be carried out as soon as possible. The first growing species which has a desirable value should be selected for the woodlot. Pruning should be done in time, which helps to produce the knot-free and desirable height of timber. Accurate tools and techniques should be used in pruning. The vacancy filling should be done in the second year of the planting during the onset of the rainy season. Healthy and a little higher than existing seedlings should be planted during vacancy filling. Special training about the management technique of woodlot should be provided by the Agricultural department and Forest department. Farmers need to be conscious of market information. The actual rotation at which the tree produces maximum wood should be known by the owner. After the rotation age, the woodlot should be harvested.

Conclusion

To fulfill the demand for food, fuel, housing, and transportation of this increased population, greater pressure has been put on the forest resource of the country. The pressure on natural forests can reduce and also increase the area of the forest land by raising private woodlots. First, growing species can raise in woodlots to fulfill our demand within a short time. Also, the owner should follow proper management techniques to get more benefits from it. Some important operations which are required to get success, such as proper planting time, site preparation, spacing, weeding, thinning, pruning, etc. should be ensured by the owners. Protection against grazing animals, fire, human interference, diseases, and pests also should be taken by the owners. However, they lack modern technology and insufficient organizational support. Proper guidance can improve existing practices. Government and responsible organizations should take initiative for assisting them and ensuring strong extension work.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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