Sustainable Agroforestry Practice in Jessore District of Bangladesh

Ripon Sheikh, Md. Akramul Islam, Arifa Sharmin, Rahul Biswas, and Joydeb Kumar

ABSTRACT

The systematic Agroforestry practice is being popular day by day in Monirampur Upazilla of Jessore district of Bangladesh. Considering this situation, the present research work was conducted with a view to know agroforestry practice and to find out the potentialities of agroforestry based on sustainability. Multistage sampling technique method by using semi-structured questionnaires was followed in the field survey to collect data and information in the year of 2014-2016 from 140 respondents in Monirampur Upazilla of Jessore district in Bangladesh to fulfill the purpose of the research. The results showed that most of the respondents are middle aged (45%), education level is primary (32%) with medium size family (54%) and 74% of the respondents are involved in agriculture. Communication exposure is very low (70%) with low organizational participation (55%). The results illustrated that the respondents preferred homestead agroforestry (55%) as their major land use practice followed by livestock under tree cover (16%), tree crop association (13%), boundary plantation (9%) and woodlot agroforestry (7%) in the research area. Besides, 80% respondents get all benefits (environmental, social, economic, and biological) followed by economic benefit directly (10%), social benefit directly (5%), environmental benefit directly (3%), and biological benefit directly (2%). Most of them (90%) get security, employment generation and household income which accelerate their livelihood pattern. Majority respondents (64%) showed more favorable attitudes, 29% respondents showed favorable attitudes, only 7% showed neutral attitudes and no one shows negative attitudes towards agroforestry. Housing condition, proper sanitation, and asset possessions before practicing agroforestry were 40%, 77% and 35% respectively and after practicing agroforestry that changed condition are 75%, 100% and 60% which revealed that peoples are benefitted due to practice of agroforestry. The result also revealed that majority primary educated respondents are involved in agriculture with medium size family mostly practiced mixed agroforestry around homestead along with livestock under tree cover, tree crop association, boundary plantation, woodlot agroforestry through possessing more favorable attitudes which ensures environmental, social, economical, biological benefits, enhance livelihood pattern, security, employment, household income etc. But communication exposure and organizational participation should be increased to adopt more technique and technology. Thus, agroforestry improve the proper utilization of resources; enhance environmentally friendly, socio-economic sustainable production system and livelihood which is socially reasonable and economically feasible through diversification of input and output which reflects that agroforestry is a sustainable system in Bangladesh.

Keywords: Agroforestry, Bangladesh, Homestead, Livelihood, Sustainable.

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I. INTRODUCTION

Bangladesh has 2.46 million ha of forestland covering about 17% of the country's area. Bangladesh Forest Department (FD) controls, manages and protects all state-owned forests except Unclassed Stated Forest (USF) [11]. More than 90% of the state-owned forest land is concentrated in 12 districts in the eastern and south-western regions of the country and out of 64 districts, 28 districts have no state-owned forest at all [15]. The per capita land

area is decreasing at an alarming rate due to increasing population [22]. This availability of land has been declined from 0.19 ha in 1961 to 0.101 ha in 1992 and now the country is claimed to have the lowest per capita arable land of 0.02 ha [23]. Agroforestry is a term used to define land-use systems that combine agricultural and silvicultural practices to produce food, wood, and other products [2], [45]. Agroforestry has also been gaining recognition as a tool for reducing poverty, improving food self-sufficiency for farmers, and increasing the productivity and income for

small scale farmers [2], [45], [32]. Likewise, numerous works of the literature reveal that agroforestry unifies a method of producing trees and crops and/or livestock in a single system on the same piece or unit of land [44]. Agroforestry has been used widely to address soil erosion and rehabilitate soil fertility [40], [43], [59], [60], [17], [26]. Even if agroforestry systems have a great potential for more sustainable use of natural resources and land, and can improve the livelihood of small scale farmers, it is important to point out that this is not a “silver-bullet” or an “one size-fits-all” approach for reconciling nature conservation and agricultural production [2], [45]. If Agroforestry systems are going to be used as a part of strategy for biodiversity conservation [47], [49].

Globally, there has been a steadily increasing interest in the development of agroforestry systems to enhance resilience. FAO has also recently issued a guide for policy-makers, Advancing agroforestry on the Policy Agenda, which aims to promote agroforestry in national policy frameworks and boost its impact [9]. Additionally, well-designed agroforestry interventions provide permanent soil cover, improve soil and water use-efficiency, restore tree cover and increase carbon stocks [46], [48], [3], [5]. Through soil fertility and, thus, productivity improvement, agroforestry contributes to food, agricultural facilities, income generation and nutritional security [6], [27], [8]. Agroforestry considered to be a best alternative for climate-smart agriculture [28] nationally and internationally; and provide an opportunity to combine the twin objectives of adaptation and mitigation [57], [39], [35], [31]. Besides the research area is located adjacent to coastal region of Sundarbans and for this agroforestry can provides different services such as medicinal values, aesthetic values, biodiversity point of view, climate resilient coastal afforestation and after all to accelerate sustainable livelihood pattern adjacent to the coastal people of Sundarbans [18]. Increasing land use pattern, positive perception towards Social Forestry especially employment opportunity for female, fuel wood facilities and selection of economically viable species accelerate to change the livelihood as alternate pattern and also increase socio-economic condition directly or indirectly in coastal belt of Sundarbans [24] and that is why agroforestry is an integral part of that coastal region. Agroforestry systems may provide efficient, productive, and/or sustainable land use but doesn't matter unless and until they are adopted and maintained over longer period of time in national and international level [52], [51]. In many countries there is an uncertainty regarding ownership of land, meaning that that the land ownership is not guaranteed [47]. Consequently, the need for intensification of agricultural production coupled with population growth forces poor farmers to expand their cultivation to marginal areas. This aggravates the degradation of natural resource and unsustainability [29]. Establishment of plantation in the poorly regenerated areas of the Sundarbans for enrichment of ecosystem and biodiversity of the Sundarbans to mitigate the climate change issues [19] and agroforestry can play similar role. As the population of this area is increasing day by day.

So, agroforestry can be a sustainable management system to meet the demand of forest produces and also to reduce

the poverty for the people of this region. Agroforestry systems are preferable to monocropping as they are able to generate income from agricultural crops, tree sales and carbon trading programs in the world, such as REDD+ schemes [50]. Public forest cannot meet the demands of the fuel wood and timber. The people in the study area directly or indirectly use the minor forest products of the Sundarbans [25] which is adjacent to the research area. Since there is neither scope for expanding forest area nor sole grain crop area, the country has to develop combined production system integrating trees and crops. Agroforestry is a dynamic ecologically based natural resources management system that through the integration of trees and sustains production for increased social, economic and environmental benefits for land users at all levels [16], [41]. Agroforestry practices offer practical ways of applying various specialized knowledge and skills to the development of rural production systems. It evolves a synergy between agricultural production and forestry that is beneficial for increased food production, sustainable management of resources and improvement of the quality of the soil. Agroforestry, among other benefits strive to optimize the use of land for agricultural production on a sustainable basis and at the same time meeting other needs from forestry. The benefit derivable from the interface between forest trees and agricultural crops are enormous. They include the optimal use of land for both agricultural and forestry production on a sustainable basis including the improvement of the quality life. Indeed the advantage of agroforestry is all encompassing is a sustainable system. This paper highlighted agroforestry practices as a sustainable system through social, economical, environmental benefits, changed condition of house, sanitation, asset possessions and changed of livelihood pattern by means of security, employment, household income of respondents of practicing agroforestry in terms of productivity, stability, and sustainability and by knowing attitudes of the respondents in the research area.

II. METHODOLOGY

A. Selection of the Research Area

Monirampur Upazilla of Jessore district in Bangladesh was selected purposively for this study (Fig. 1). Total eight (8) unions among Seventeenth (17) unions are selected randomly to conduct this research and two (2) villages from each union (except Moshimnagor and Jhapa) were chosen randomly. Multistage sampling technique was adopted to collect data and information to conduct the study. Thus, total fourteenth (14) villages were selected and total one hundred and forty (140) farmers (Ten farmers from each village) were interviewed, and a reconnaissance survey was carried out in the research area in the year of 2014-2016 through a set of questionnaire to fulfill the purpose of the research.

Fig. 1. Map of the research area (Source: Google maps).

TABLE 1: NAME OF ALL SAMPLING UNITS IN THE RESEARCH AREA

Name of the district	Name of the Upazilla	Name of the Unions	Name of the Villages
Jessore	Monirampur	Horidaskathi	Hogladanga Bahadurpur Sheikhpara Mashna
		Khanpur	Khusarikuna Kaziara
		Durbadanga	Hazrakhati Jhaljara
		Monirampur	Kultia Mohisdia
		Kultia	Nehalpur Kalibari
		Nehalpur	Moshimnagor Chandipur
		Moshimnagor	
		Jhapa	

Source: Field survey, 2014-2016.

TABLE 2: MEASUREMENT OF VARIABLES OF THE RESEARCH

Variables	Measurement
Age	Young age (up to 30), middle age (31 to 45) and old age (above 45)
Education	Primary level (up to class eight), Secondary level, Above HSC (Higher secondary level) and illiterate (who did not know reading or writing).
Family size	Small family (Contain the members of 2-5), Medium family (Contain the members of 6-9) and large family (Contain the members of above 9).
Homestead area	Landless and marginal, Small (0.03-0.09 ha), Medium (0.09-0.15 ha) and Large (above 0.15 ha).
Annual income	Below 5000 Tk., 5001-100000 Tk., 100000-150000 Tk., and Above 150000 Tk.
Communication exposure	High, medium, low.
Organizational participation	High, medium, low, and nil.

B. Field Survey, Data Collection, Processing, and Analysis

Filed survey was carried out in selected village to obtain relevant information, data by using the semi-structured questionnaire (question were asked in Bengali but written in English language). After field survey and data collection, data regarding agroforestry were arranged and converted

into percentage, and information regarding agroforestry was presented in tabular form by using MS word and MS Excel.

III. RESULTS

Age of the respondent is ranged from 16 to 65 years with an average of 42.03. The respondents are classified into three categories as young age (up to 30) is about 28%, middle age (31 to 45) is about 45% and old age (above 45) is about 27% (Table 3). In this research the farmers; which are related with agroforestry, among them 40% of farmers have secondary level education whereas 16% of them are illiterate, 32% are primary level and 12% are of higher secondary level. The family members are about 2-12. Most of the farmers have medium (6-9) families (54%) compared to 31 % small (up to 5) and 15% large (above 9) families (Table 3). The homestead of the farmer ranged from 0.01-0.23 hectare with an average 0.06 hectare. Among the farmers 23% are landless and marginal, 17% are medium (0.06-0.09 ha), 7% are large (above 0.09) homesteads and while 53% are small (0.03-0.09 ha) homestead (Table 3). From the survey, it found that 74% of the respondents are involved in agriculture (Table 3). 12% of the respondents are labor. They have no land. They work others land at a

daily payment basis. Beside that 8% of the respondents' occupations are business and rest 6% are service. Communication exposure is very low in the study area contributing the percentage is low (70%), medium (25%) and high (5%) (Table 3). The organizational participation is also very low in the study area. It is classified as four types, high (5%), medium (10%), low (55%), and nil (30%) (Table 3).

TABLE 3: DEMOGRAPHIC FEATURES OF THE RESPONDENTS IN THE RESEARCH AREA

Selected characteristics	Categories	Percentage (%) of farmers
Age	Up to 30 years	28
	Middle aged (31-45 year)	45
	Old (Above 45 year)	27
Education	Primary level	32
	Secondary level	40
	Higher secondary level	12
	Illiterate	40
Family size	Small (up to 5 members)	31
	Medium (6-9 members)	54
	Above 9 members	15
Homestead	Small (0.03-0.9 ha)	53
	Medium (0.06-0.09)	17
	Large (Above 0.09)	7
	Landless	23
Occupational status	Agriculture	74
	Labor	12
	Business	8
	Service	6
Per year family income	Below Tk. 5000	2
	Tk. 5001-Tk.100000	25
	Tk. 100000- Tk.150000	40
	Above Tk. 150000	33
Communication exposure	Low	70
	Medium	25
	High	5
Organizational participation	High	5
	Medium	10
	Low	55
	Nil	30

A. Practiced Agroforestry in the Research Area

Agroforestry systems are practiced vastly in the selected Monirampur Upazilla in Jessore district which includes the woody perennials like raintree (*Somanea saman*), mahogany (*Swietenia mahagoni*), neem (*Azadirachta indica*), ipil-ipil (*Leucaena leucocephala*) etc. and the variety of fruit trees like mango (*Mangifera indica*), coconut (*Podocarpus nerifolia*) etc. There are various type of crops associate with homestead i.e. mustard, gram, sesames, jute, paddy, wheat, lentil etc. Various types' vegetable like brinjal, onion, cauliflower, potato, ladyfinger, arum, karolla, potol, bean, ladysfinger, piper etc. After extensive survey of the selected area, the following agroforestry practiced were identified.

1. Homestead agroforestry

In case of homestead agroforestry in research area, any fixed system or design of agroforestry cannot be practiced by the farmer. Generally they have been associated tree, crops, and vegetables with random spacing. In homestead forestry farmers meet up their fruits, vegetables, fuel wood and timber demands. Am (*Mangifera indica*), jam (*Syzygium cumini*), coconut (*Podocarpus nerifolia*), jackfruit (*Artocarpus heterophyllous*), guava (*Psidium guajava*), banana (*Musa spp*), lamon (*Citrus aurantifolia*), dalim (*Punica granatum*) etc. fruit species are plant for fruit

demand as well as extra income. For timber production mahogany (*Swietenia mahagoni*) was first choice of the respondents. Bamboo is the common multipurpose species in homestead forestry in the study area. In small scale they also planted eucalyptus (*Eucalyptus camaldulensis*), koro (*Albizia procera*), kadam (*Anthocephalus chinensis*), and nim (*Azadirachta indica*) etc. timber producing species. Along with the fruit species and timber species they also planted different types of seasonal crops and vegetables, i.e. mustard, gram, pigeon pea, pea, sesames, jute, paddy, wheat, and lentil etc. Various types of vegetable like brinjal, cucumber, onion, cauliflower, potato, ladyfinger, arum, balsam-apple, parble, bean, ladyfinger, and pepper etc. Different types of livestock's like cow, goat, ram, duck, hen, pigeon etc. also rare in homestead agroforestry system. The farmers grow multipurpose trees in their homegardens for flowers, fruits, and seeds, trees, fish, agricultural crops, cattle, etc. which is shown in Table 4. In the research area, most of the respondents practiced homestead agroforestry and it is 55% (Fig. 2).

TABLE 4: CROPS ASSOCIATION WITH MAJOR TREE SPECIES

S.L. No.	Agroforestry Practiced in the research area	Species found in the research area
1.	Homestead Agroforestry	<i>Mangifera indica</i> , <i>Artocarpus heterophyllus</i> , <i>Syzygium cumini</i> , <i>Cocos nucifera</i> , <i>Azadirachta indica</i> , <i>Swietenia macrophylla</i> , <i>Manilkara zapota</i> , <i>Areca catechu</i> , <i>Citrus maxima</i> , <i>Basella alba</i> , <i>Lagenaria siceraria</i> , <i>Typhonium trilobatum</i> , <i>Cucurbitamoschata</i> , <i>Benincasa hispida</i> , <i>Vignases quipedalis</i> , <i>Carica papaya</i>
2.	Tree- crop association	<i>Phoenix sylvestris</i> , <i>Borassus flabellifer</i> , <i>acacia auriculiformis</i> , <i>Mangifera indica</i> , <i>Swietenia macrophylla</i> , <i>Citrus limon</i> , <i>Corchorus capsularis</i> , <i>Momordica charantia</i> , <i>Amaranthus lividus</i> , <i>Solanum melongena</i> , <i>Pisum sativum</i>
3.	Boundary plantation	<i>Phoenix sylvestris</i> , <i>Borassus flabellifer</i> , <i>Cocos nucifera</i> , <i>Swietenia macrophylla</i> , <i>Samanea saman</i> , <i>Carica papaya</i> , <i>Musa sapientum</i> , <i>Moringa oleifera</i> , <i>Basella alba</i>
4.	Livestock under tree cover	<i>Mangifera indica</i> , <i>Manilkara zapota</i> , <i>Citrus limon</i> , <i>Psidium guajava</i> , <i>Litchi chinensis</i> , <i>Azadirachta indica</i> , <i>Bostaurus</i> , <i>Bubalus bubalis</i> , <i>Capra aegagrus hircus</i> , <i>Ovis aries</i> , <i>Equus caballus</i> , <i>Columba livia</i>
5.	Woodlot Agroforestry	<i>Swietenia macrophylla</i> , <i>Samanea saman</i> , <i>Dalbergia sissoo</i> , <i>Albizia lebbek</i>

Fig. 2. Agroforestry practiced by the respondents in the research area.

2. Tree- crop association

Tree-crop association is a very important factor for the success of any agroforestry practices. In tree- crop association traditionally farmers have been grown different

types of vegetables under tree. Sometime farmers also uses tree as the support of creeper of vegetables. Some agroforestry system has been proved as a very unique production system. In surveyed region turmeric, ginger, potato, catjong, bottle ground is found. In place where trees are very large and mature turmeric, ginger, and arum are found to be grown under trees. As land areas are high only Aman paddy is found to be grown under tree in very few places. Respondents' shows favorable motivation to tree-crop association and plant tree-crop to gain their benefits from agroforestry (Table 4). In the research area, 13% practiced tree-crop association agroforestry (Fig. 2).

3. Boundary plantation

Boundary plantation has been practiced around the agricultural land. Farmers were practice boundary plantation for protection of annual crops from strong wind, control soil erosion, support climber species and other purposes. In boundary plantation farmers plant timber species and fruit species on the boundary of the agricultural land. They also plant different types of vegetables like papaya (*Cracia papaya*), brinjal (*Solanum melongena*), turmeric (*Curcuma longa*), karala etc. In the field they cultivate mainly paddy (*Oryza sativa*), jute (*Corchorus olitorius*) annual crops and different types of seasonal vegetables. From boundary plantation the farmers' also earn extra income by selling fruits, vegetables, timber, fuel wood, fodder etc. Farmers were maintaining 6"×6" and 8"×8" spacing in case of tree species (Table 4). In the research area, 9% practiced boundary plantation (Fig. 2).

4. Livestock under tree cover

From the survey, it was found that 25% of the respondents has domestic animal within their homestead area. Livestock under tree cover has been practiced under sisso (*Dalbargia sissoo*), mahagoni (*Swietenia mahagoni*), coconut (*Cocos nucifera*), and rain tree (*Somania saman*) etc. species. Cow, goat, ram, duck, hen, pigeon etc are practiced by the farmer. Cow, goat, ram in this system must be associated under large size trees as if they may not be harmful for those trees (Table 4). In the research area, 16% practiced livestock under tree cover agroforestry system (Fig. 2).

5. Woodlot agroforestry

Woodlot plantation is another common agroforestry practice in Monirampur Upazilla of Jessore district. Mainly the multipurpose tree species is preferred in this system. The major woodlot species in Monirampur Upazilla are mehogoni, rain tree, sisso, ipil-ipil, eucalyptus, akashmoni etc. (Table 4). In the research area, 7% practiced woodlot agroforestry because of its rapid large amount cash return (Fig. 2).

B. Benefits of Practicing Agroforestry in the Research Area

In agroforestry, combinations of trees, crop and livestock are intentionally designed and managed as a whole unit within short period of time. Agroforestry system consists of one or more. Whereas, an agroforestry practice indicates specific land management actions on a farm and other management units in spatial and temporal scheme [14]. The biological, physical and chemical interaction among the crop and the livestock components are manipulated to

enhance the agricultural production and thus provide many tangible and intangible benefits to the respondents in the research area. Agroforestry is ecologically sound practices that have little to zero adverse effect on natural ecosystems which enhance environmental quality and the natural resource base. Alternative uses of land that are economically profitable can improve the economic viability of a farm: improving soil management and crop rotation can increase yields, enhance soil quality and water availability which can raise the value of the farm an respondents in the research area. Economic viability can be achieved through reduction on the usage of machinery, chemical fertilizer and pesticide costs through practicing agroforestry. Agroforestry relates to the quality of life of those who work and live on the farm, as well as those in the surrounding communities in the research area. In the research area, 10% respondents get economical benefit directly, 5% respondents get social benefit directly, 3% respondents get environmental benefit directly, and 2% respondents get biological benefit directly (Fig. 3). On the contrary, 80 % respondents get all benefits (Environmental, social, economical, biological) simultaneously (Fig. 3).

Fig. 3. Benefits of practicing Agroforestry in the research area by the respondents.

C. Change of Livelihood Pattern due to Practice of Agroforestry

Agroforestry is an integral part of the rural livelihood systems for centuries in Bangladesh and plays a key role in providing household food and energy security, income and employment generation [37]. The integration of trees, agricultural crops, and/or animals into an agroforestry system has the potential to enhance soil fertility, reduce erosion, improve water quality, enhance biodiversity, increase aesthetics, and sequester carbon [12]. In terms of potentiality to mitigate adverse climate impact and to improve soil quality, agroforestry can offer significant economic and social impact to the respondents. Agroforestry can not only improve food security from healthier soils but it can also introduce resources that can be used by households or sold for additional income and thus it is capable of creating a diverse farm economy and stimulating the entire rural economy resulting in more stable communities and farms. In the research area, only 4% respondents got security due to practice agroforestry, only 3% respondent's got employment generation directly through practice of agroforestry, 3% respondents can gather their household income facilities directly (Fig. 4). On the

contrary, 90 % respondents get all of these (provide security, employment generation, household income) livelihood pattern. simultaneously (Fig. 4).

Fig 4. Change of livelihood pattern due to practice of agroforestry in the research area.

D. Farmer's Attitudes towards Agroforestry in the Research Area

Agroforestry has been defined as a dynamic ecologically based natural resources management system through the integration of trees on farms and in the agricultural landscape diversifies and sustains production in whole world nationally and globally. It provides social, economic and environmental benefits for land users at all levels. On the other hand, agroforestry practices in the croplands and homesteads play a vital roles in increasing tree coverage and to supply annual, perennial and animal products and services. That is why farmers possess favorable attitudes towards practice of agroforestry in the research area. In the research area 64% respondents showed more favorable attitudes towards agroforestry. 29% respondents showed favorable attitudes towards agroforestry (Fig. 5). Therefore, only 7% showed neutral attitudes towards agroforestry. But it is significant that no respondents showed negative attitudes towards agroforestry (Fig. 5).

Fig. 5. Farmer's attitudes towards agroforestry in the research area.

E. Change of Condition due to Agroforestry Practice

Housing condition of the targeted households was taken into consideration to analyze the effects of agroforestry in the study area. In this regard, the respondents are interviewed to know the construction materials (e.g., soil, brick, bamboo, wood, galvanized iron, etc.) used for building their houses (particularly floor, wall and roof) in Jessore district of Bangladesh. The result revealed that the percentage of changed housing condition before practicing

agroforestry was 40%. But after practicing agroforestry it is 75% which is very significant changing the condition of the respondent's sustainably (Fig. 6). The effects of agroforestry practice on sanitation condition of the targeted households are studied under the research. It was noticed that before practicing agroforestry 77% respondents got proper sanitation and percentage was changed into 100% after practicing agroforestry (Fig. 6). So, the result of this research signifies that the sanitation condition of the respondents was improved due to the practice of agroforestry which also indicates the health and hygiene environment of their living places. The targeted households were interviewed regarding their household assets. These assets were bicycle, motorcycle, van/rickshaw, television, tube well, pump machine, cow, goat, etc. It meant that they had better income through agroforestry practice which they utilized for their better housing condition. They spent some portions of their increased income into the betterment of their housing condition which was also an indicator for their better living status. The results showed that these assets were increased due to practice of agroforestry in the research area (Fig. 6). In the research area, 35% respondents got benefitted through changing asset possessions from agroforestry practice and it is 60% now due to agroforestry practice (Fig. 6). These increased household assets were playing an important role for their safety net and reducing their poverty as well as to improve their living quality.

Fig. 6. Change of condition due to agroforestry practice in the research area.

IV. DISCUSSION

Agroforestry is an integral part of the rural livelihood systems in Bangladesh and plays a key role in providing household food and energy, security, income and employment generation, investment opportunities and environmental protection as well as sustainable livelihood pattern. As a vulnerable area e.g., Jessore district in Bangladesh practice of agroforestry is being popular day by day. In the research area, the highest (40%) of the farmers were in the secondary level, middle aged (31 to 45) (45%) and medium size (6-9 members) family (54%) with primary occupation of agriculture (74%) which denotes that agroforestry is a sustainable landuse management pattern to the middle aged medium size family with secondary level of education. Nurunnaharet *al.* [42] found in Kaligong that,

most of respondents were middle-aged farmers, male, and practice homestead agroforestry. Most of the respondents showed favorable attitudes (93%) followed by neutral attitudes (7%) and no one shows negative attitudes towards agroforestry which shows similar result (94.12% positive attitudes) with Sharmin and Rabbi [54] in Jhenaidah District of Bangladesh and they also mentioned that the middle aged farmers (42.7%) were mostly interested in adopting agroforestry in similar place of Bangladesh. Homestead agroforestry or homegarden is being more popular by the respondents in the research area. Most of the respondents practiced homestead agroforestry (55%) and 13% practiced tree crop association, 9% practiced boundary plantation, 16% practiced livestock under tree cover and only 7% practiced woodlot agroforestry as they got socio-economic, environmental, ecological, social, biological benefits from agroforestry. Agroforestry can provide the next step in sustainable agriculture by promoting and implementing integrated, biodiversity processes [58] and homegarden is a complex sustainable agroforestry system [38]. Gautam *et al.* [13] reported that homegarden contributed 60% of total consumption of agroforestry in India. Saha *et al.* [50] found that homestead agroforestry is the most common agroforestry practice (39.28%) in Faridpur, Bangladesh. Another study conducted in north-eastern Atlantic forest biome in Brazil by Klie [38] revealed that most of the farmers (89%) working with agroforestry systems generates more income than working with conventional agriculture and they also showed positive views on livestock under tree crops. Therefore, Sharmin and Rabbi [54] stated that in Jhenaidah district, 32% respondents are now practicing woodlot plantation, and this may be due to massive demand of local wood. Similar study by Saha *et al.* [50] showed 13.09% respondents practiced woodlot plantation. On the contrary, Chakraborty *et al.* [4] stated that, cropland agroforestry is a land based production system that is directly related to food security, employment, income opportunities and environmental issues which also plays a vital role in rural socio-economic development as well as poverty reduction. Agroforestry is a dynamic, ecologically based natural resource management system that, through which the integration of trees/woody perennials in farm and rangelands, diversifies and sustains production for increased social, economic and environmental benefits [33]. Most of the respondents (80 %) got all benefits such as Environmental, social, economical, biological and the rest 20% got environmental, social, economical, biological benefits simultaneously in the research area. Simelton *et al.* [55] and FAO [9] came to the same conclusion that benefits from agroforestry are usually reaped in the middle and long terms, hence, given the poverty of the farmers in the region, promotion of agroforestry should be accompanied by strong government support. However, this finding supports with Montagnini and Nair [38] and they identified economic benefits (product diversification), agronomic benefits (soil protection, control of pathogens, extended cropping season), and social benefits due to practice of agroforestry. Lutgarda *et al.* [34] postulates that sustainability can be achieved if environmental stability, socioeconomic productivity, and social acceptability are all achieved, and agroforestry is a strategy that can help achieve sustainable

development in the Philippines which possesses similarity with Klie [30]. Agroforestry is an integral part of the rural livelihood systems and plays a key role in providing household food and energy security, income and employment generation, investment opportunities and environmental protection [36]. Majority (90 %) respondents get all of these (provide security, employment generation, household income) and the rest 10% got all these benefits separately. Saha *et al.* [50] revealed similar result in case income generation and farm productivity as well as livelihood pattern. Findings of Hoang *et al.* [20], clearly indicated that agroforestry ensures environmental sustainability and food security. Therefore, Talukder [56], indicates that more than 85 percent of the farmers given their opinion that agroforestry practices increase agricultural development through sustain production in Bangladesh. The result revealed that the percentage condition before practicing agroforestry was insignificant e.g. housing condition (40%), sanitation (77%), and asset possessions (35%) but after practicing agroforestry condition have changed significantly and most of the respondents got proper housing (75%) and gain asset possessions (60%) properly. It is noticeable that, 100% respondents got proper sanitation in the research area because of practicing agroforestry. Therefore, results and respondents clearly stated that agroforestry ensures sustainability in terms of practice, benefits, changing livelihood pattern and by changing their condition also mentioned by Horrigan *et al.* [21] and mentioned that agroforestry as a sustainable management system. Alao and Shuaibu [1] mentioned that agroforestry is a dynamic ecologically based natural resources management system that through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic, and environmental benefits for land users at all levels.

This paper concludes that agroforestry has a great potential in promoting sustainable development in Jessore, Bangladesh. The direct benefits that it provides to individual farmers clearly address the economic dimension. The indirect benefits from providing environmental services (e.g., carbon sequestration, improving microclimate, providing soil erosion control) ensure the ecological balance of the whole community. The science and practice of agroforestry is ultimately geared towards promoting sustainable development by improving the socioeconomic productivity, environmental sustainability, accelerate livelihood pattern of the practitioners without sacrificing the environment, particularly the forest and agricultural resources. The environmental services provided by Agroforestry will in the long run provide a healthy environment. The aims of agroforestry practice are consistent with the concept of sustainable development. Thus, the study recommends that information on agroforestry practices should be disseminated through effective means among farming households and proper collaboration among different organization. Communication exposure (70%) and organizational participation (55%) is very low in the research area which should be accelerated to enhance agroforestry marketing and adopting new technology and thus ultimately increase agroforestry

production to accelerate sustainability. At the same time farmers' association should be bolstered. Additionally, the channel of information dissemination should be improved to facilitate the utilization of agroforestry practices in the research area. Thus, the paper suggests that there might be other driving factors influencing the adoption of agroforestry practices. By researching other determinants, this can provide further insight for research on how to drive adoption of new technology or practices beyond awareness, more effective means of practicing agroforestry, by finding more collaboration about practicing agroforestry and so on.

V. PROBLEMS FACED BY FARMERS IN AGROFORESTRY IN RESEARCH AREA

The special problem of Monirampur is Vabodaha problem, frequent water stagnation occurs since 2005. As a result, huge home stead and agriculture land area went under water during rainy season. Agroforestry practice has long been hampered in Vabodaha region. During dry season and also insufficient rain in the rainy season farmers face serious irrigation problem. Again due to frequent power cut, farmers cannot run smoothly their saw machine for water supply in their field. Sources of planting materials were not adequate in the site. Most of the cases the respondents have collected planting materials from long distance and at a high price. Due to planting trees in cropland, harmful birds, pests/insects etc. get suitable habitat on these trees. So these birds and insects can easily damage the annual crops. In case of cropland Agroforestry, farmers face plashing and laddering problem because of shallow root systems. Sometimes natural disaster and grazing animal's damage crops. Sometimes conflicts arise with the neighbor farmers because trees spread roots and provide shade on their land. Farmers were not got real price of their products. They sell their products in local market because in some areas the communication system was not well with Jessore district and also lack of vehicles and high transport cost. In Agroforestry system, lands is cultivated again and again and thus reduce soil nutrients. Some farmers require training, technical facilities etc. on different agroforestry systems. The farmers do not get adequate support from agricultural office or other organization, most of respondent says they support from NGOs and other organization is very poor.

VI. RECOMMENDATIONS

Suitable tree and vegetable species for a climatic area should be selected. To avoid shade effect, species should be selected wisely. More attention should be given on proper care and management of the system to gain more profit. Tree species and vegetables having more economic and food value should be planted. Seedlings should be raised locally on potential sites near the field. This will ensure good supply of planting materials at a reasonable price. Nitrogen fixing multi-purpose tree species should be select for maintaining and increasing soil fertility. Selection of low crown diameter species provides less shade in cropland. Deep rooted species could not hamper ploughing and laddering. Bangladesh is also an overpopulated country,

so it has important to involve local people with ecotourism [7] and agroforestry may be an important issues for local people for the development of ecotourism. It also helps to minimize the conflict with neighbor farmers. Some place of Monirampur is in water stagnant condition (i.e., Vabodaha) and if, it is not possible to avoid this situation species that tolerate water stagnation should be selected. Floating vegetable cultivation system can be practiced. Where use big size pot or tub for cultivation and grown up climber type vegetable like bean, pumpkin, catjon etc. Where irrigation problems are found farmers can dig narrow channel in one side of their land for storing water. They also collect water from nearby water body with pump machine. Necessary efforts should be taken by the concerned authorities e.g., Government and non-government organization though training programs for farmers, extension workers, and NGO representatives on proper planning, designing, management and maintained of the agroforestry system.

VII. CONCLUSION

Farmers have been practicing agroforestry systems from time immemorial. So, to fulfill their family needs; they practice different types of agroforestry in their land. This helps them to improve their socio-economic condition. Agroforestry are more popular in the study area but no systemic or modern agroforestry system is followed there. Generally they have been practicing mixed homestead agroforestry, livestock's under tree, tree-crops association and also popular boundary plantation which has great potential to improve social and economic conditions. It was found that farmers become interested about fast growing species but fruit yield species still first choice for the homestead area. In case of crops and vegetable, seasonal vegetable and crops are practiced by them. They also introduce shade tolerate species of vegetables which can grow well under tree. On the other hand, some areas of the homestead were found unutilized that could be used for growing more trees and vegetable crops. In fact, they lack in modern technology and their organizational support is not adequate. In this situation proper guidance to farmers on different aspects of agroforestry can make the improvement of existing practice. For this, Government has to take initiative to establish local level organization for assisting agroforestry and also for strong extension work.

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