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Productivity analysis of timber and fruit tree-based agroforestry practices in Madhupur Sal forest, Bangladesh

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Abstract

In developing countries, different agroforestry systems have been promoted as a pathway to increase household incomes and to generate environmental benefits that are well suited to poor farmers. Thus, a study was carried out in the Madhupur Sal forest of Bangladesh to find out the suitable agroforestry systems based on their productivity. Five agroforestry practices namely Akashmoni tree with Ginger and Banana crops, Akashmoni tree with Turmeric and Banana crops, Akashmoni, Acacia Hybrid, Ghoraneem, and Gamar trees with Turmeric crops, Jackfruit and Akashmoni trees with Turmeric and Aroid crops, and Litchi tree with Pineapple, Ginger, Papaya and Banana crops were randomly selected. The non-agroforestry systems (NAFs) for each of the aforesaid practices were also selected. The study showed that all the selected agroforestry practices were more profitable than their NAFs. The net profit indicated that Litchi- Pineapple- Ginger- Papaya- Banana based agroforestry practice was financially more profitable than the other practices while the benefit-cost ratio (BCR) and land equivalent ratio (LER) were higher (3.66 and 1.76 respectively) in Akashmoni- Ginger- Banana agroforestry practice followed by Litchi- Pineapple- Ginger- Papaya- Banana, Akashmoni- Turmeric- Banana, Akashmoni- Acacia Hybrid- Ghoraneem- Gamar- Turmeric, Jackfruit- Akashmoni- Turmeric- Aroid based practices. Even though Litchi- Pineapple- Ginger- Papaya- Banana based agroforestry practice gave higher net profit, the cost required for this practice was much higher. On the other hand, soil pH and content of organic matter, total nitrogen, phosphorus, and potassium in soil of all of the selected agroforestry practices showed higher values than their NAFs. Soil fertility status showed that Akashmoni- Ginger- Banana based agroforestry practice was more fertile as compared to other land uses. The findings revealed that integrated agroforestry systems are more productive than monoculture or NAFs. Both economical and ecological point of view, Akashmoni- Ginger- Banana based agroforestry practice was more suitable than the other practices in the Madhupur Sal forest of Bangladesh.

Introduction

The degradation of natural resources, especially the land and forest of Bangladesh has become a matter of serious concern because the enormous population of the country (FAO, 1999). Deforestation is nothing but a prime cause of soil erosion and land degradation (Barbier, 1998). Under such conditions, it is needed to identify the alternate systems that sustainably increase productivity as well as conserve natural resources therein by combining trees and crops like agroforestry system. Agroforestry, a land-use system featured by growing different species of woody perennials in association with field crops, is a suitable land-use system specifically for degraded areas. It controls soil erosion, reverses environmental degradation through biological interactions of trees and crops and increases income from farmland (Sanchez, 1994; Garity, 2004). Being a land-use system, agroforestry has been notably considered as an effective and low-cost method as it does help to minimize the process of degradation associated with land cultivation and also for its retention of the ecosystem (Vergara and Nicomedes, 1987). During the last decades, different agroforestry systems have been promoted in developing countries as a means to increase household incomes and to generate environmental benefits that are well suited to poor farmers (Franzel *et al.*, 2004).

Bangladesh was rich in forest resources but with the pace of population explosion rapid degradation takes place in its forest reserves. In Bangladesh, Sal forests cover an area of about 120,000 ha which accounts for about 0.81% of the total land and 7.5% forest coverage (BFD, 2017). The Sal forest mainly constitutes two parts; the Madhupur Sal forest and the Bhawal Sal forest area. The Madhupur Sal forest is popularly known as Madhupur Garh. Recent statistics showed that about 50,000 forest-dependent people including ethnic minorities are living in and around the 21 villages of the Madhupur Sal forest area mostly rely on agroforestry practices which offer multiple alternatives and opportunities to improve farm production and income

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and also providing productive and conservative functions to the ecosystems (Alam *et al.,* 2010; Islam *et al*., 2013). The agroforestry programs at the Madhupur Sal forest area contributed more than 46% of the forest dependents people's household income (Islam *et al*., 2013).

In the Madhupur Sal forest area, the most important crop and tree products those are mostly preferred by the farmers of different agroforestry practices are pineapple, ginger, aroid, turmeric, banana, papaya and poles, pulpwood and firewood as these trees are mostly short-rotation species (Islam *et al*., 2013; Kibria and Saha, 2011). Farmer-led agroforestry production systems to this forest have already been provided food, timber, fodder, firewood, fruit, construction materials and another small scale enterprise (Alam *et al*., 2010; Hossain *et al.,* 2015; Muhammad *et al.,* 2005). But the majority of the local farmers do not have the scope to compare those local potential agroforestry practices for further improvements with technological supports. Therefore, it is required to know about different agroforestry practices, their benefits and their effect on natural resources to maintain sustainable development of this forest. Nevertheless, it is important for policymakers to know which agroforestry systems better serve to income and improve the livelihood of rural people. Unfortunately, there is lacking such kind of research in the Madhupur Garh area. Therefore, this research work was carried to analyze the productivity of timber and fruit tree-based agroforestry practices in the Madhupur Sal forest area.

Materials and Methods

The study area

The study was performed in the Madhupur Sal forest under the Tangail and Mymensingh Forest Division which is popularly known as the Madhupur Tract or Garh. The tract lies between 23º50' to 24°50' North latitude and 89°54' to 90°50' East longitude (Fig. 1). Recent statistics of the local Madhupur forest office state that the total area of this forest is about 63,001.89 acre (45565.18 acre in Tangail and 17436.71 in Mymensingh districts) acres comprising five ranges namely National Park, Dokhola, Aronkhola, Madhupur and Rasulpur (Local Forest Department, 2018). The tract consists of Pleistocene terraces and recent alluvial floodplain. It occupies the central part of the Ganges- Brahmaputra-Meghna Delta. During the dry season, the soil is compact and hard, but melts with the rainfall and becomes soft and tenacious. The soils of the areas are highly oxidized reddish brown clay with moderate to strong acidic reaction (Alam, 1995).

Location and sampling design

The study was conducted in four villages' viz. Gaira, Joloy and Magontinagar of Madhupur Upazila under Tangail district and Sataria under Muktagacha Upazila of Mymensingh district (Fig. 2). This study dealt with five agroforestry practices having 0.2 ha area for each sample plot along with a non-agroforestry system (except tree) for each combination.

Selected agroforestry practices in the study area

In the Madhupur Sal forest, five existing timber and fruit tree-based agroforestry practices were selected by baseline survey, practical observation, consulting with local people etc.

A list of the selected existing agroforestry practices are-

1. Akashmoni (*Acacia auriculiformis*)- Ginger (*Zingiber officinale*)- Banana (*Musa sapientum*)
2. Akashmoni (*Acacia auriculiformis*)- Turmeric (*Curcuma longa*)- Banana (*Musa sapientum*)
3. Akashmoni (*Acacia auriculiformis*)- Acacia hybrid (*Acacia spp.*)-Gamar (*Gmelina arboria*)- Goraneem (*Melia azedarach*)- Turmeric (*Curcuma longa*)
4. Jackfruit (*Artocarpus heterophyllus*)- Akashmoni (*Acacia auriculiformis*)- Turmeric (*Curcuma longa*)- Aroid (*Colocasia esculenta*)
5. Litchi (*Litchi chinensis*)- Pineapple (*Ananas comosus*)- Papaya (*Carica papaya*)- Ginger (*Zingiber officinale*)- Banana (*Musa sapientum*)

Collection of data for productivity analysis

Productivity is commonly defined as a ratio between the output volume and the volume of inputs. In other words, it considers a key source of economic growth and competitiveness and, as such, is basic statistical information for many international comparisons and country performance assessments (Krugman, 1994). Under agroforestry systems, productivity considers the production and fertility of the land. A questionnaire survey, interview, and practical observation method were used to gather data regarding different agroforestry land-use information and physical yield data for productivity analysis viz. cost of production, income, Benefit-Cost Ratio (BCR), Land Equivalent Ratio (LER), as well as soil fertility. For the vegetative survey, measuring tape and Sunto clinometer were used for different measurements. At the same time, soil samples were also collected from the selected plots to find out the impact of agroforestry practices on resource conservation especially the nutrient status of the soil.

Data collection

In order to calculate crop produce, different parameters like number of fruits /plant, weight of fruits /plant (kg), crop or fruit price (Tk/kg), cost of production (Tk/ha), crop yield (kg/ha), income (Tk/ha) were collected from the sample plots. For analyzing the productivity of tree components, parameters like number of trees /plot, bole diameter (cm), bole height (ft), timber price (Tk/cft), cost of production (Tk/ha), tree yield (kg/ha and cft/ha), income (Tk/ha) were gathered from the selected plots.

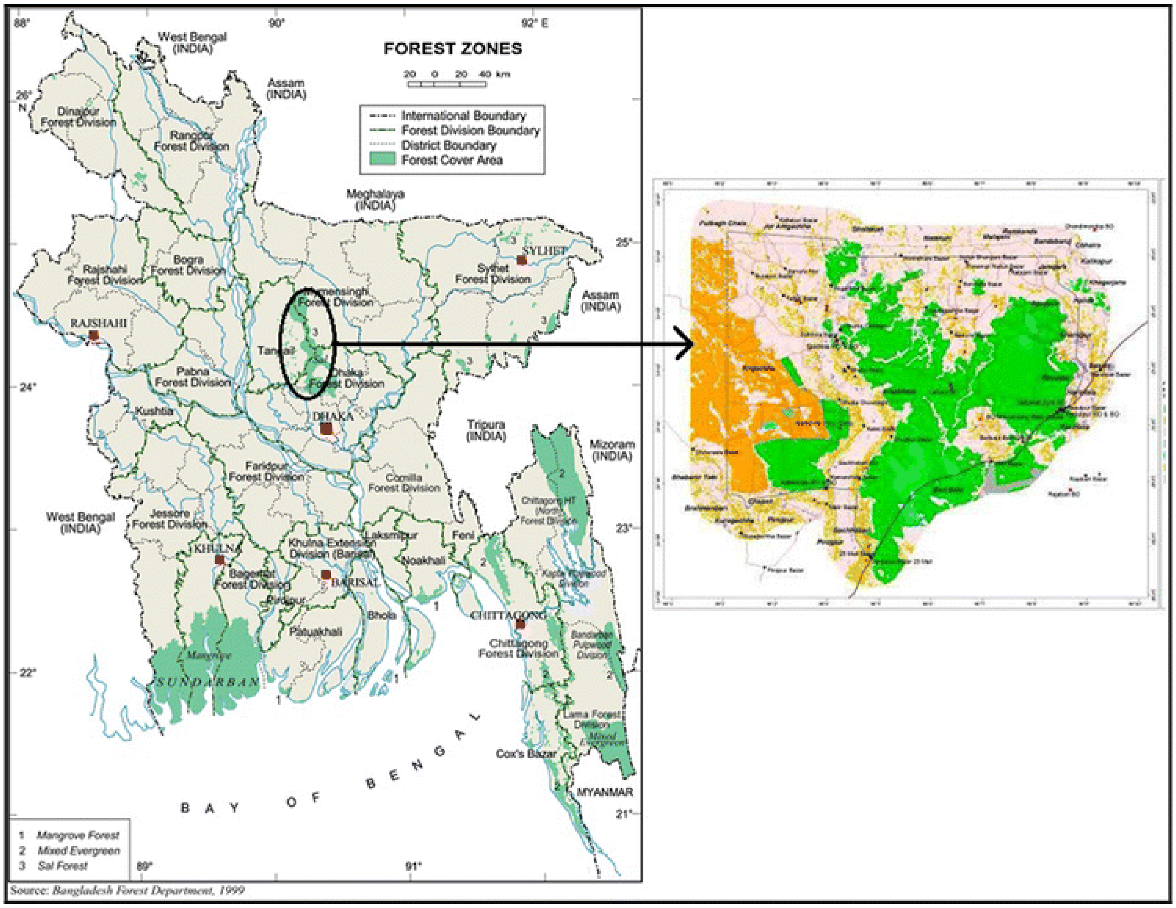
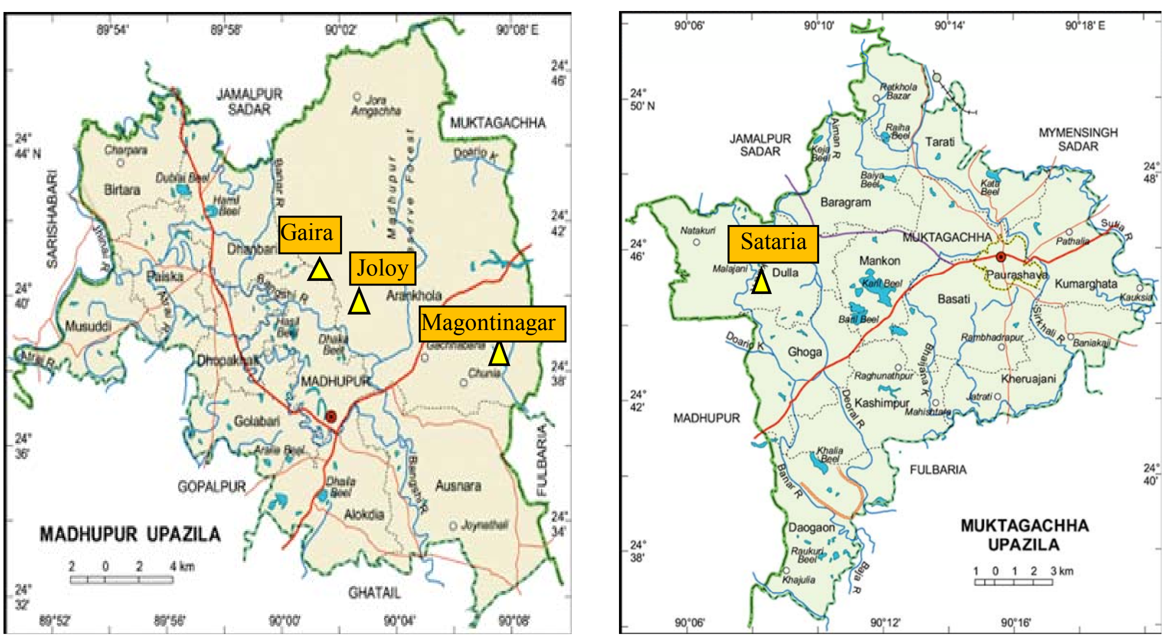


Fig. 1. Forest map of Bangladesh showing Madhupur Sal Forests (MSF) (Islam *et al*., 2015



A **B**

Fig. 2. Map showing the selected villages of (A) Madhupur Upazila of Tangail district and (B) Muktagacha Upazila of Mymensingh district (Banglapedia, 2015)

Soil sample collection, preparation and analysis

A total of 25 (5 in each agroforestry practice) plots in existing agroforestry land uses and 25 plots (10 m × 10 m Quadrate plot) in non-agroforestry practices were established to collect the soil sample. From each quadrate plot, five soil cores were taken and mixed to make a composite sample. Then the soil samples were air-dried, processed and sieved through 20 mesh sieves and packed with a specific tag for laboratory analysis. The chemical analysis of soil samples was done in the Humboldt Soil Testing Laboratory, Department of Soil Science, Bangladesh Agricultural University, Mymensingh. Soil pH was measured by using Glass-electrode pH meter (WTW pH 522) at a soil-water ratio of 1:2. Organic carbon was determined by the wet oxidation method of Walkley and Black (1934). Total nitrogen was determined by the micro-Kjeldahl method (Jackson, 1958). Available P was extracted by the Molybdenum blue method of Bray and Kurtz using a spectrophotometer (Jackson, 1958). Exchangeable K was determined by 1N NH_4OAc extract method using flame photometer (Page *et al*., 1989).

Calculation of production cost

The cost includes land preparation cost, labor cost, seed/seedling cost and, intercultural operation and maintenance cost (fertilizer, pesticide, weeding, etc) related to the production.

Calculation of total income

Benefits received by farmers include agricultural outputs, price of fruits, pruning materials used and sold as fuel and timber both from thinning and final harvest. Benefits obtained from the timber species are accounted as average income per year as the research was carried out for two years. Total income can be computed by multiplying total yield of tree and crop species with their market price.

Total income (Tk) = Total yield (t/ha) × Market price (Tk/kg)

It is mentionable that in case of timber species the yield and income related information were collected from the farmers and the volume of the standing trees were also measured as following method- Volume = $\pi r^2 h$ (cft)
Where, r= radius (cm) and h= height (ft)

Income of tree products (Tk/ha) = Volume (cft/ha) ×Price per unit (Tk/cft)

Calculation of Benefit-Cost Ratio (BCR)

The benefit-cost ratio (BCR), which indicates the rate of return per unit of cost, was calculated using the following formula (Islam *et al*., 2004):

Benefit-cost ratio (BCR) = Gross income / Total cost of production

The BCR greater than 1 indicates that the land-use system is profitable.

Calculation of Land Equivalent Ratio (LER)

Land equivalent ratio (LER) is derived from its indication of relative land requirements for intercrops versus monocultures. It helps to find the relative performance of a component of a crop combination compared to the sole stands of that species (Mead and Willey, 1980).
LER can be expressed as:

$$LER = Ci/Cs + Ti/Ts$$

Where, Ci is crop yield under agroforestry, Cs is crop yield under sole cropping, Ti is tree yield under agroforestry, and Ts is tree yield under sole cropping.

If *LER=1*, there is no advantage (i.e., neutral) to intercropping or agroforestry in comparison to sole cropping. If *LER>1*, indicate better use of resources or positive interaction between the tree and crop components. If *LER<1*, indicate the competition i.e., negative interactions between the tree and crop components.

In this study, the LER was calculated considering some deviation of the mentioned equation. Where, the LER was the ratio of the yield obtained from agroforestry plots to the yield of the non-agroforestry systems (Absence of tree species).

Statistical analysis

The obtained data were scrutinized and edited before putting the data in analyzing sheets. Then data were entered into the computer and analyzed by using MS excel software and ANOVA technique with the help of Statistix 10 to examine the variation of the results for different practices.

Results and Discussion

Economic performance of the selected agroforestry (AF) practices

Akashmoni-Ginger-Banana based AF practice

Income from the sale of different products and all costs were assessed to analysis the economic aspect of the study. However, the BCR and LER are the common indicators of economical performance as both cost and return components are counted here. The results revealed that the total cost incurred for the cultivation of 1 ha land during the study period was Tk 138350 (Table 1). On the contrary, the benefit recorded from this practice was Tk 506883 where banana contributed about 45% of the total income. However, income received from its non-agroforestry system (NAFs) was Tk 402584 (Table 6). The BCR and LER analysis clearly indicated that this land-use system was more profitable than the NAFs (BCR 3.66 and LER 1.76 in Akashmoni-Ginger-Banana based agroforestry practice where BCR 2.92 in

NAFs) (Tables 1 and 6). The result was corroborated with the findings of Nayak *et al.* (2014) where the highest gross return (Tk 525187.46/ha), net return (Tk 301074.76/ha) and BCR (2.34) were recorded under *Acacia mangium* with pineapple based agrisilvicultural (Tree-crop based) system as compared to other agrisilvicultural systems and sole crops in Bhubaneswar, India. Similar result was observed by Kumari and Madan (2016) where they found that the yield performance of four perennial medicinal plants- *Glycyrrhiza glabra*, *Asparagus racemosus*, *Aloe-vera*, and *Tinospora cordifolia* (0.37 t/h, 1.8 t/ha, 14.5 t/ha, and 14.76 t/ha, respectively) under Poplar based agroforestry systems was better compare to the sole cropping in Odisha, India.

Table 1. Economic performance of Akashmoni-Ginger-Banana based agroforestry practice

Year	Production Cost (Tk/ha)	Income (Tk/ha)	BCR	LER
2017	96240	257905		
2018	42110	248978	3.66	1.76
Total	138350	506883		

Note: Taka (TK) Bangladesh local currency, 1 USD= 85 TK

Akashmoni-Turmeric-Banana based AF practice

The economic analysis stated that the total cost incurred for this practice was Tk 124552 where the initial cost was the highest of Tk 82216 in the year 2017 which was reduced in the next year of production (Table 2). According to the yield analysis, total income calculated for Akashmoni-Turmeric-Banana based agroforestry practice was Tk 358997 while the total income of its NAFs (absence of tree) was Tk 281132 (Table 6). On the other hand, the results of BCR and LER clearly indicated that this land-use system was more profitable than the NAFs (BCR 2.88 and LER 1.58 in Akashmoni-Turmeric-Banana based agroforestry practice where BCR 2.36 in NAFs) (Table 2 and Table 6). Dwivedi *et al.* (2007) found a similar outcome for poplar based agri-silviculture system than a poplar and eucalyptus based bund system in India. The results were corroborated by Jaimini *et al.* (2006) where higher fodder yield of 4.95 t/ha was obtained from below the tree canopy followed by between tree rows of 4.03 t/ha and the lowest forage yield was 3.87 t/ha observed in sole dhaman grass (*Cenchrus ciliaris*) in the absence of *Prosopis cineraria* in Gujarat, India.

Table 2. Economic performance of Akashmoni-Turmeric-Banana based agroforestry practice

Year	Production Cost (Tk/ha)	Income (Tk/ha)	BCR	LER
2017	82216	141810		
2018	42336	217187	2.88	1.58
Total	124552	358997		

Akashmoni-Acacia hybrid-Gamar-Goraneem-Turmeric based AF practice

Under this agroforestry practice, the production cost measured for the cultivation of 1 ha land at the time of the study was Tk 97950. While the benefit recorded from this practice was Tk 230541 where about 36% of the total income received from non-woody components (Turmeric) (Table 3). On the contrary, the benefit obtained from its non-agroforestry system (NAFs) was Tk 117843 (Table 6). The BCR (2.35) and LER (1.58) clearly indicated that this practice was profitable while the BCR of its NAFs was 1.99 (Table 3 and Table 6). The result was supported with the findings of Alam *et al.* (2010) where they indicated that the agroforestry production system in the Madhupur Garh was more profitable than the cultivation of the agricultural crop. Similar findings were found by Rahangdale *et al.* (2014) where they recorded the highest average monetary return of Tk 25024.51ha^{-1} from bamboo based agrisilvicultural system compared to sole crops, which gave Tk 11663.19 ha^{-1}. In agroforestry system, the highest financial return of Gamar (Tk 86836.68 of total boundary plants), papaya (Tk 1118941.53 ha^{-1}), pea (Tk 34843.2 ha^{-1}), gram (Tk 73631.25 ha^{-1}), and Indian mustard (Tk 18492.6 ha^{-1}) whereas in sole plantation, the financial yield of Gamar (Tk 25473.14 of total boundary plants), papaya (Tk 964020.19 ha^{-1}), pea (Tk 33462.8 ha^{-1}), gram (Tk 60803.05 ha^{-1}), and Indian mustard (Tk 17368.05 ha^{-1}) in Jharkhand, India (Kumar, 2012).

Table 3. Economic performance of Akashmoni-Acacia hybrid-Gamar-Goraneem-Turmeric based agroforestry practice

Year	Production Cost (Tk/ha)	Income (Tk/ha)	BCR	LER
2017	67862	54160		
2018	30088	176381	2.35	1.58
Total	97950	230541		

Jackfruit- Akashmoni -Turmeric-Aroid based AF practice

From the results, the incurred cost of production for this practice was Tk 95153, while the benefit earned was Tk 212071 during the study period (Table 4). Moreover, the BCR and LER calculated for this land-use system were 2.23 and 1.53 which revealed that this practice was profitable for the farmers in the study area (Table 4). In the case of its NAFs, the total income and BCR were Tk 161309 and 1.95 (Table 6). Rahman *et al.* (2018) found higher net return, BCR and LER from jackfruit based agroforestry system were BDT 557863, 4.56 and 2.17, respectively than their sole cropping systems in Narsingdi district of Bangladesh. Similar findings were also recorded by Hasan *et al.* (2008) in jackfruit based agroforestry systems in the Madhupur Garh which were very supportive to the present findings.

Table 4. Economic performance of Jackfruit-Akashmoni-Turmeric-Aroid based agroforestry practice

Year	Production Cost (Tk/ha)	Income (Tk/ha)	BCR	LER
2017	64859	87857		
2018	30294	124214	2.23	1.53
Total	95153	212071		

The Net Present Value (NPV) and Benefit-Cost Ratio (BCR) of the pineapple based agroforestry systems in the Madhupur Sal forest were Tk 487010.79 and 5.35 respectively (Rana, 2010).

Litchi-Pineapple-Papaya-Ginger-Banana based AF practice

According to the result the total cost incurred for this practice was Tk 180958. On the contrary, the benefit received from this practice was Tk 592913 (Table 5) whereas income received from its non-agroforestry system (NAFs) was Tk 535108 (Table 6). In BCR and LER analysis, it was observed that this agroforestry practice was much more profitable than its NAFs (BCR and LER of Litchi-Pineapple-Papaya-Ginger-Banana based agroforestry practice were 3.28 and 1.69, respectively while BCR for its NAFs was 2.99) (Table 5 and Table 6). The highest benefit-cost ratio (3.54) was recorded from coconut with guava based multistoried agroforestry which was higher than their sole cropping (1.65) (Bari and Rahim, 2012). Litchi based agroforestry system ensured a higher return and more sustainable than sole cropping system (Hanif *et al*., 2010).

Table 5. Economic performance of Litchi-Pineapple-Papaya-Ginger-Banana based agroforestry practice

Year	Production Cost (Tk/ha)	Income (Tk/ha)	BCR	LER
2017	119891	279087		
2018	61067	313826	3.28	1.69
Total	180958	592913		

Comparison of the selected agroforestry practices with their NAFs

According to the result, it was found that all the selected agroforestry combinations were more profitable than their NAFs in terms of their total benefits (Table 6).

According to the BCR and LER analysis, it had been found that Akashmoni-Ginger-Banana based agroforestry practice was the most profitable having BCR of 3.66 and LER 1.76 followed by Litchi-Pineapple-Papaya-Ginger-Banana, Akashmoni-Turmeric-Banana, Akashmoni-Acacia Hybrid-Gamar-Ghoraneem-Turmeric, Jackfruit-Akashmoni-Turmeric-Aroid based agroforestry practices (Table 6).

Table 6. Economic performances of different cropping systems

Cropping Systems		Total Production Cost (Tk/ha)	Gross return (Tk/ha)	Net profit (Tk/ha)	BCR
Akashmoni-Ginger-Banana	Agroforestry	138350	506883	368533	3.66
	NAFs	137630	402584	264954	2.92
Akashmoni-Turmeric-Banana	Agroforestry	126052	358997	232945	2.88
	NAFs	119265	281132	161867	2.36
Akashmoni-Acacia hybrid-Gamar-Ghoraneem-Turmeric	Agroforestry	97950	230541	132591	2.35
	NAFs	58975	117843	58868	1.99
Jackfruit-Akashmoni-Turmeric-Aroid	Agroforestry	95153	212071	116918	2.23
	NAFs	82475	161309	78834	1.95
Litchi-Pineapple-Papaya-Ginger-Banana	Agroforestry	180958	592913	411955	3.28
	NAFs	178560	535108	356548	2.99

Note: NAFs= Non agroforestry system

Table 7. Effect of different cropping systems on soil properties in the Madhupur Sal forest area

Cropping Systems		pH	OM (%)	Total N (%)	P (ppm)	K (meq/100g)
Akashmoni-Ginger-Banana	Agroforestry	4.77	2.69	0.16	42.74	0.32
	NAFs	4.71	2.43	0.13	15.54	0.29
Akashmoni-Turmeric-Banana	Agroforestry	4.38	2.60	0.15	33.89	0.29
	NAFs	4.86	2.01	0.10	21.40	0.26
Akashmoni-Acacia hybrid-Gamar-Ghoraneem-Turmeric	Agroforestry	4.77	2.58	0.15	30.89	0.27
	NAFs	4.56	2.35	0.11	19.01	0.19
Jackfruit- Akashmoni- Turmeric-Aroid	Agroforestry	4.75	2.55	0.15	23.01	0.24
	NAFs	4.72	2.46	0.14	22.99	0.18
Litchi-Pineapple-Papaya-Ginger-Banana	Agroforestry	4.58	2.52	0.14	32.00	0.31
	NAFs	4.76	2.24	0.12	29.87	0.28

Similar findings were observed by Alam *et al.* (2010), Dwivedi *et al.* (2007), Hossain *et al.* (2015) in which it was concluded that agroforestry systems were economically more profitable compare to their sole cropping systems. Hasan *et al.* (2008), Hanif *et al*. (2010) and Rana (2010) also showed the similar types of results in their researches and all of the scientists argued that that agroforestry is a profitable land-use system.

Soil fertility status of the cropping systems

Chemical analysis of the soil samples showed that soil fertility status was improved under the selected agroforestry practices compare to their NAFs (Table 7). From the results, it was recorded that organic matter, total N, available P, exchangeable K content of the selected agroforestry practices were higher than the non-agroforestry systems in the absence of trees. But in the case of Akashmoni with Ginger and Banana based agroforestry practice, all values of the soil properties were higher than the other agroforestry practices. The result indicated that all the agroforestry practices improved soil fertility status as well as conserve natural resources in the Madhupur Sal forest. Kibria and Saha (2011) reported that pineapple agroforestry was more fertile than rest of other agroforestry systems in the Madhupur Sal forest area. Soil fertility increased from mono-crop to agroforestry soils, observed by Gupta *et al.* (2009). Improvements of soil characters after practicing bamboo based agroforestry were found by Shanmughavel *et al*. (2000). Similar trends were also recorded by Hasan *et al*. (2005); Rahman (2006). Pandey *et al.* (2002) recorded the soil properties like organic carbon, available N, P and k under neem plantations were 0.11 %, 38.90 kg ha^{-1}, 5.14 kg ha^{-1} and 62.55 kg ha^{-1} respectively, which were much more higher over control plots (without tree).

Conclusion

In the economic view point, the Akashmoni with Ginger and Banana based agroforestry is much more suitable than the other agroforestry practices. The result also indicates that soil nutrients under different agroforestry practices are utilized more efficiently in comparison to the non-agroforestry systems. All of the selected agroforestry practices are more suitable than their non-agroforestry systems both in economic and ecological points of view. Through agroforestry, farmers can get their food, fuelwood, fodder, timber as well as could increase their income from the same unit of land. So, poor farmers in different areas of our country could improve their livelihood with the conservation of natural resources by adopting these sustainable production systems rather than traditional monoculture. In addition, tree coverage of the country could be raised through practicing different agroforestry systems, which helps to reduce the deforestation problems. Therefore, it is plausible to advocate for the promotion of timber and fruit tree-based agroforestry practices as it requires comparatively low investment, helps to improve soil properties and provides continuous benefits throughout the year.

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