Journal of Agroforestry and Environment

Volume 16, Issue 2, 2023

Journal DOI: https://doi.org/10.55706/jae

Journal homepage: www.jagroforenviron.com

Homestead Agroforestry and Tree Species Diversity in Cumilla District of Bangladesh

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Received: 07/10/2023

Accepted: 12/12/2023

Available online: 16/12/2023

Abstract: In Bangladesh, the typical land use structure is homestead agroforestry. It provides people with basic necessities like food, shelter, money, and other things. This study was regulated in the Nangalkot Upazila of the Cumilla district at Bangladesh to identify plant species grown in homestead areas and to explore the relationships between tree diversification and selected characteristics of farmers of the Nangalkot upazila. A total of 50 households from the small, marginal, medium, and large groups were polled. An interview schedule was created using a simple technique and questionnaire to collect data on the selected parameters. The respondents were chosen at random, and data were collected between January 1 and 21, 2021. For statistical analysis, the orthodox descriptive statistical parameters and Product Moment Correlation Coefficient of Pearson (r) were used. A total of twenty seven (27) plant species were identified in the study area's homestead, with 16 being fruit plants and 11 being forest plant species. The most abundant fruit species were mango, coconut, guava, papaya, jackfruit, etc., and the forest plant species were mahogany, bamboo, eucalyptus, neem, akashmoni, etc. On average, 14.38 plant species had been identified in respondents' homestead area. Sixteen agroforestry systems with four layers were identified from the study area. Selected farmers' characteristics, such as family size, farm size, homestead size, knowledge about homestead agroforestry, and socio-economic condition, showed a significant positive relationship with the total number of plant species, which can help in nutritional security of the people in the area of study. The current homestead agroforestry techniques in the Nangalkot Upazila of Cumilla district can be improved using advanced agroforestry approaches, and diversity of medicinal and multipurpose plants should be enhanced in order to maximize farmers' revenue.

Keywords: Homestead agroforestry; Tree diversity; Nangalkot upazila.

INTRODUCTION

Bangladesh is predominantly an agricultural nation, and it's significantly contributing to the country's economy (Shabuj *et al.*, 2010). Bangladesh, which has a total population of 154.4 million and a 1.37 percent per year expansion rate, is one of the world's most inhabited nations (BBS, 2016). Agriculture approximately contributes 11.63% of the GDP and generates employment opportunities in the country (BBS, 2021). In Bangladesh, there are approximately 32.07 million homesteads, and more than 74% of people live in rural areas (Haque *et al.*, 2018). Homesteads are exceptionally productive and occupy about 7% of Bangladesh's 7.63 million ha of cultivable land (World Bank, 2011).

To maintain ecological variety and prosperity, A homestead is a unique ecosystem that includes humans, animals, fishponds, plants, and trees (Ullah, 2021; Nair, 1990). As a result, agricultural communities and rural residents gain from a favored domestic system of production with farming as well as other output enterprises. In Bangladesh, the traditional land use arrangement is homestead agroforestry (Roy *et al.*, 2013). It meets people's basic needs, for example, food, shelter, and money (Vieira *et al.*, 2012; Haque *et al.*, 2018). People plant or keep multipurpose trees in their homes under this framework.

Homestead agroforestry refers to the close relationship between usable shrubs and trees, seasonal and perennial plants etc. Fernandes and Nair (1986) reported that the tree-crop-animal combination is maintained by farmers. It is an extremely intricate, multi-strata coordinated production system that incorporates every facet of farming (trees, crops, animals, and occasionally fisheries) and giving millions of people access to chances for work, earning capacity, and food safety (Miah *et al.*, 2003).

Bangladesh is a South Asian country with one of the world's densest populations. Because of the increasing population growth rate, more housing and food are required. As a result, agricultural land and forestland are shrinking (Hasan, 2013). For the conditions mentioned above, such as population growth and deforestation, agroforestry would be a suitable alternative land management option, particularly in the household area. According to Hanif *et al.* (2018), agroforestry is the blending of agriculture and reforestation with features of production, environmental sustainability, and acceptance. In this regard, one of the promising agroforestry systems is homestead agroforestry. Homestead agroforestry is an essential part of the job procedures of provincial families and, until now, the most outdated arrangement of creation in Bangladesh, with little regard for biological systems. In general, families have been growing vegetables, organic products, and wood species and raising domesticated animals in their miniature homestead locales to supply their numerous everyday demands. This is an improved system of cultivation that is administered and governed by members of the family, especially women. Farmers in Bangladesh with minimal resources would benefit most from household agroforestry systems. While they wait for future tree revenues, they can gain from crops. This research aimed to identify the diverse tree species and current agroforestry system practices in the Nangalkot upazila of Cumilla district.

MATERIALS AND METHODS

Geographical coordinates of the study location

The study was regulated in Bangladesh's Cumilla district at Nangalkot Upazila (Figure 1). The geographical coordinates of the Nangalkot upazila are 23° 7' 18" North, and 91° 15' 26" East.

Variables of the study

Farmers age, education, size of family, size of farm, size of homestead, annual income, knowledge of homestead agroforestry, and socio-economic conditions were the independent variables of the study. Dependent variable was the number of tree species in the homestead zone.

Methods of data collection

Overall, 50 households were interviewed, including marginal, small, medium, and large homes. A questionnaire and a short interview schedule were employed to collect data on the selected parameters. The respondents were chosen at random, and the data were collected between January 1 and January 21, 2021.

Data processing and analysis

The gathered information was examined, organized, and evaluated systematically in light of the study's objectives. These survey results were analyzed using the MS Excel package and SPSS (version 25^{+}). For statistical analysis, the orthodox descriptive statistical parameters and Product Moment Correlation Coefficient of Pearson (r) were used.

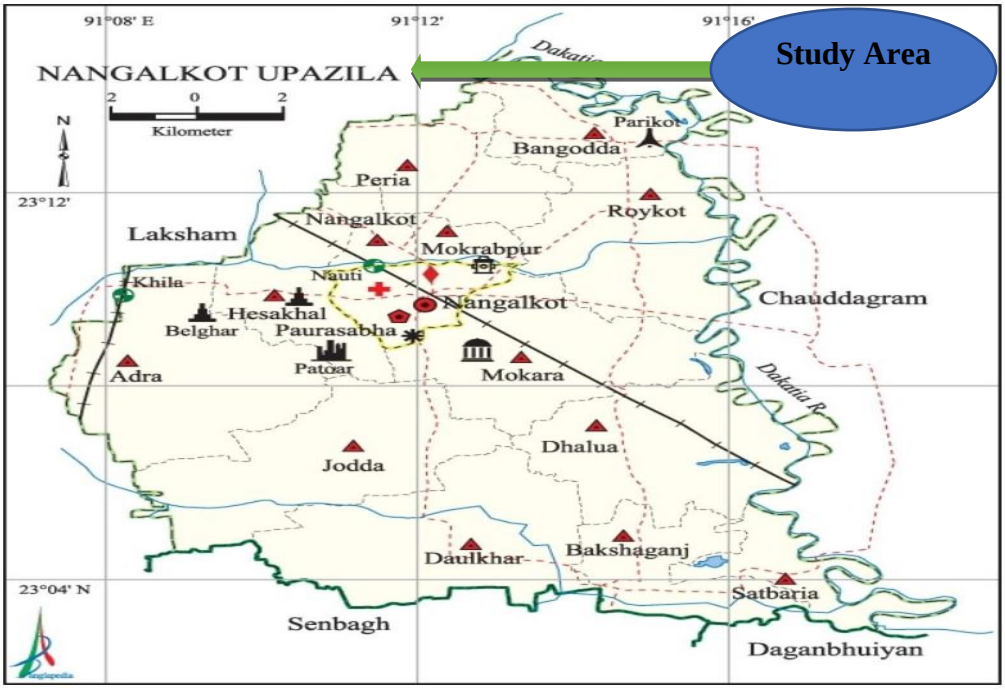

Figure 1. The map of the Nangalkot upazila in Cumilla district (Banglapedia, 2015)

DOI: https://doi.org/10.55706/jae1632

RESULTS AND DISCUSSION

Respondents' characteristics in the area of study

The independent variables are shown in Table 1. The participants' ages ranged from 27 to 65 years old, with a mean age of 44.70 years and a standard deviation of 9.807 years. According to Begum et al. (2013), the average age of the farmers in Tangail district's Gopalpur Upazila was 41.7 years. The farmers had a mean of 5.10 and a standard deviation of 3.765 for educational background, which ranged from 0 to 12. Singha et al. (2019) in the Kamalganj upazila of the Moulvibazar district obtained nearly identical findings. The family sizes of the respondents ranged from 1 to 10, with a standard deviation of 2.431 and a mean of 5.08. Begum *et al*. (2013) and Ullah (2021) reported similar findings in their study area. The standard deviation of farm size in this study was 0.683, with an average of 0.736 hectares. Hanif *et al*. (2018) discovered that the average farm size distribution of 100 respondents was 53% small farms, 17% marginal farms, 23% landless, and 7% large farms. The respondent's average homestead size in the Nangalkot Upazila of Cumilla district is 04156 hectares, with a standard deviation of 0.029. Basak (2002) reported that between farm size and homestead area, there is a positive relationship exists. The survey found that the respondents' yearly income ranged from 80 to 120 (in thousand taka), with a mean of 107.18 and a standard deviation of 21.988. The knowledge of homestead agroforestry among the respondents was measured on a scale of 0 to 20, with a mean score of 11.38 and a standard deviation of 4.823. The socioeconomic status of the respondent had a score between 12 and 20, with a mean of 16.30 and a standard deviation of 5.712.

Table 1. Description of the farmer's characteristics in the study (N=50)

Characteristics	Measuring unit	Observed range	Mean	Standard deviation
Age	Years	27-65	44.70	9.807
Education	Years of schooling	0-12	5.10	3.765
Size of family	Number of people	4-8	5.08	2.431
Size of farm	Hectare	0.20-2.00	0.74	0.683
Size of homestead	Hectare	0.02-0.09	0.042	0.0294
Annual Income	Taka (Thousand)	80-120	107.18	21.988
Knowledge of homestead agroforestry	Score	8-16	11.38	4.823
Socio-economic conditions	Score	12-20	16.30	5.712

**Authors investigation, 2021*

Categorization of respondents according to the number of trees observed in their homestead agroforestry system

The number of trees observed in the homestead agroforestry system ranged from 3-27 Species, with an average of 14.38 and a standard deviation of 6.51 (Table 2). Table 2 exhibits that 11-20 species were found in most of the respondents' homestead areas (44%) & only 24% of the respondents' homestead areas possess above twenty (20) tree species.

Table 2. Categorization of respondents according to the number of trees observed in their homestead agroforestry system

Category	Frequency	Percent	Range	Mean	S.D. (±)
Small (up to 10 trees)	16	32			
Medium (11 to 20 trees)	22	44	3-27	14.38	6.51
High (above 20 trees)	12	24			
Total	50	100			

**S.D. = Standard Deviation*

Plant species detected in the homestead area

In the homestead areas, various tree species were discovered. Because of the large size of the homestead area, where several trees were planted, the large farm family contained the greatest number of tree species. Furthermore, the marginal farmers had a small homestead area where only necessary trees were planted. In 50 residences, a total of 27 different tree species were identified, with 16 being fruit trees and 11 being forest trees species (Table 3).

DOI: https://doi.org/10.55706/jae1632

Table 3. List of different fruit and forest tree species observed in the homestead area

SL No.	Common Name	Scientific Name	No. of Respondents	Percentage (%)
Different fruit plant species				
1.	Mango	*Mangifera indica*	42	84
2.	Coconut	*Cocos nucifera*	38	76
3.	Guava	*Carica guajavam*	35	70
4.	Papaya	*Carica papaya*	34	68
5.	Jackfruit	*Artocarpus heterophyllus*	31	62
6.	Supari	*Areca catechu*	28	56
7.	Banana	*Musa sapientum*	21	42
8.	Boroi	*Ziziphus mauritiana*	17	34
9.	Lemon	*Citrus limon*	16	32
10.	Kamranga	*Averrhoa carambola*	13	26
11.	Amra	*Spondias mombin*	11	22
12.	Jalpai	*Elaeocarpus floribundus*	8	16
13.	Jambura	*Citrus grandis*	7	14
14.	Chalta	*Dillenia indica*	5	10
15.	Jam	*Syzygium cumini*	5	10
16.	Bael	*Ziziphus mauritiana*	3	6
Different forest plant species				
1.	Mahogany	*Swietenia macrophylla*	35	70
2.	Bamboo	*Bambusa vulgaris*	33	66
3.	Eucalyptus	*Eucalyptus citriodora*	30	60
4.	Neem	*Azadirachta indica*	29	58
5.	Akashmoni	*Acacia auriculiformis*	24	48
6.	Segun	*Tectona grandis*	19	38
7.	Dumur	*Ficus spp.*	8	16
8.	Raintree	*Albizia saman*	7	14
9.	Koroi	*Albizia Procera*	7	14
10.	Arjun	*Terminalia arjuna*	5	10
11.	Sissoo	*Dalbergia sissoo*	3	6

The Figure 2 and Figure 3 depict the dominant fruit and forest tree species available in the area of study. Among the fruit species, the most dominant species were mango, coconut, guava, papaya, jackfruit, supari, banana etc. and the most dominant forest species were mahogany, bamboo, eucalyptus, neem, akashmoni, segun etc. in the study area for ecological and socioeconomic reasons. Shabuj *et al.*, (2010) reported that jackfruit, eucalyptus, kalokoroi, tal and raintree were dominant plant species in the homestead area of Natore district in Bangladesh. Haque *et al.*, (2018) found that akashmoni, acacia hybrid, mahogany, nilotica and jarul were dominant tree species and mango, jamrul, golapjam, jam and jackfruit were dominant fruit species in their study area. This could be because of differences in the study area's climatic conditions, soil characteristics, and socioeconomic conditions.

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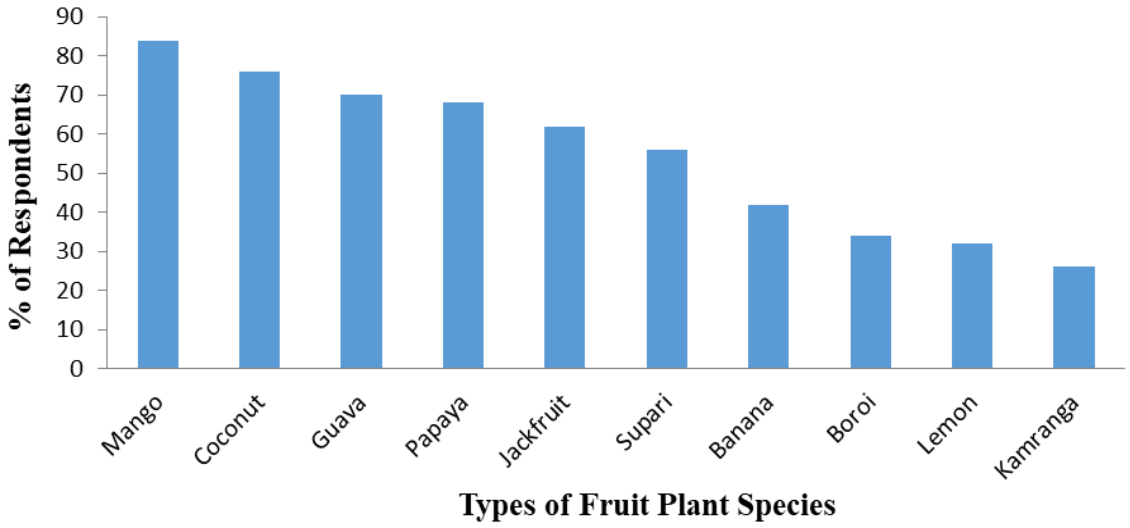

Figure 2. Ten major fruit plant species in the area of homestead of Nangalkot Upazila at Cumilla district

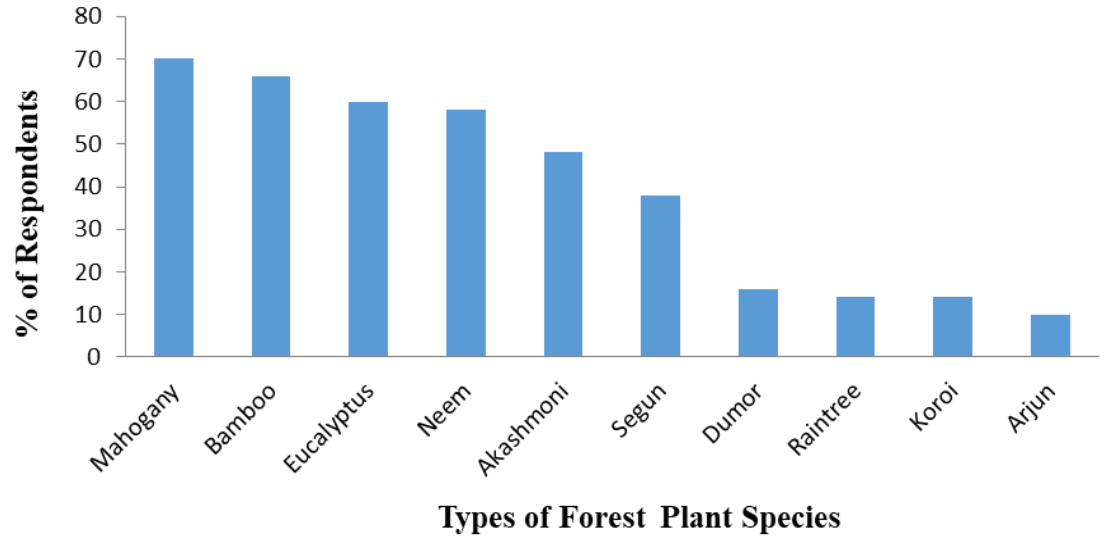

Figure 3. Ten major forest plant species in the area of homestead of Nangalkot Upazila at Cumilla district

Agroforestry systems in the homestead area

Several vertical levels, or strata, were found in the studied region. According to Basher (1999), vertical strata of homestead agroforestry in Bangladesh can be categorized as L_1 = Within 1 m, L_2 = 2-5 m, L_3 = 5-10 m, and L_4 = >10 m. All these four vertical layers were observed in the present study (Table 4).

From these four layers, sixteen (16) different plant combinations of agroforestry systems were identified by respondents, and these are presented in Table 5. It was observed that homestead area had the highest 81.25% of agrosilviculture system compared to agrosilvopastoral (12.5%) and silvopastoral (6.25%) systems, respectively (Table 5). Eleven distinct conventional agroforestry practices were found by Hanif et al. (2018) in the Pabna district. Singha et al. (2018) identified 29 different agroforestry systems in Moulivibazar district's Kamalganj upazila.

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Table 4. Vertical strata of homestead agroforestry in the study area

Layer	Height (m)	Examples
L_1	0-1.5	Country bean, Chili, Brinjal, Sweet potato, etc.
L_2	1.51-3.5	Banana, Papaya, Guava, etc.
L_3	3.51-7.0	Guava, Banana, Jackfruit, Jam, etc.
L_4	>7.0	Mango, Mahogany, Eucalyptus, etc.

Table 5. Different agroforestry systems in the study area

Existing crop-tree combination	Classes of agroforestry systems
Mango-Country Bean-Betel nut	Agrosilviculture
Jackfruit-Country Bean-Betel nut	Agrosilviculture
Jackfruit-Betel nut-Mango	Agrosilviculture
Chalta-Coconut-Mango	Agrosilviculture
Banana-Eucalyptus-Papaya	Agrosilviculture
Bottle gourd-Mango-Poultry	Agrosilviculture
Bottle gourd-Brinjal-Mango	Agrosilviculture
Jackfruit- Brinjal-Livestock	Agrosilvopastoral
Coconut-Mango-Country Bean	Agrosilviculture
Banana-Wax gourd-Coconut	Agrosilviculture
Betel nut-Mango	Agrosilviculture
Guava-Mango	Agrosilviculture
Mango-Sponge gourd-Livestock	Agrosilvopastoral
Coconut-Betel nut	Agrosilviculture
Pomelo-Betel nut-Coconut	Agrosilviculture
Livestock-Bamboo	Silvopastoral

Table 6 demonstrates a statistically significant positive association between the variety of tree species in the area of homestead and a number of respondents' characteristics, with the exception of age and education. These characteristics included size of family, size of farm, size of homestead, annual income, knowledge about homestead agroforestry, and socioeconomic situation. Shabuj *et al.* (2010) also found that age, size of family, size of farm and household size had positive significant relationship with tree diversification in the Natore district of Bangladesh. Yasmin *et al.* (2010) found that age, family size, farm size, homestead size, and annual income had positive significant relationship with tree diversity in the area of homestead of Madhupur upazila under Tangail district.

Table 6. Relationship between the numbers of tree species in the homestead area with the selected attributes of the respondents in the study area

Dependent variable	Independent variable	Correlation Coefficient 'r'
Number of tree species in the area of homestead	Age	-0.153
	Education	0.141^{NS}
	Size of family	0.766**
	Size of farm	0.816**
	Size of homestead	0.862**
	Annual income	0.827**
	Knowledge of homestead agroforestry	0.872**
	Socio-economic condition	0.847**

CONCLUSION

The study area contained 27 tree species ranging from 3 to 27, with Mango, Coconut, Guava, Eucalyptus, Neem, and Mahogany dominating. Agroforestry practices were observed in four distinct vertical strata within the investigated area, resulting in sixteen possible combinations. It was discovered that the most prevalent type of agroforestry system is agrosilviculture (about

DOI: https://doi.org/10.55706/jae1632

81.25%). Respondents chose species for agroforestry classes primarily based on family demand. A significant positive connection was observed between size of the family, homestead & farm, annual income, knowledge in agroforestry & socio-economic condition and the tree species number in the area of homestead. The current homestead agroforestry techniques in the Nangalkot Upazila of Cumilla district can be improved using advanced agroforestry approaches, and the diversity of medicinal and multipurpose plants should be enhanced in the study area in order to maximize farmers' income.

Acknowledgement

The authors want to express their sincere gratefulness to the "Sylhet Agricultural University Research System (SAURES)" for providing research funds.

Conflict of Interest

There are no conflicts of interest mentioned by the authors.

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