J. Sylhet Agril. Univ. 10(2): 19-26, 2023 **ISSN: 2308-1597**

EXISTING AGROFORESTRY PRACTICES AND ITS ROLE IN UPLIFTING FARMERS LIVELIHOODS: A CASE STUDY OF GOLAPGANJ UPAZILA OF SYLHET DISTRICT

S Datta[1], MSA Talucder[1*], M Das[1], RM Turin[1], MS Uddin[1]

[1]*Department of Agroforestry and Environmental Science, Sylhet Agricultural University, Sylhet 3100, Bangladesh*

(Available online at www.jsau.sau.ac.bd)

Abstract

In many nations around the world, including Bangladesh, agroforestry has long been a crucial component of rural subsistence. It is a sustainable land-use practice that can simultaneously promote the achievement of at least 9 out of 17 Sustainable Development Goals (SDGs), especially SDG 1 (poverty reduction), SDG 2 (zero hunger), SDG 13 (climate action) and SDG 15 (sustainable life on land). The present study was designed to document the present status of agroforestry practices and its role in improving the livelihoods of farmers in Golapganj of Sylhet in Bangladesh. Data were collected through personal interview from 60 randomly selected respondents from the village Gondamara and Turupbag of Bagha union of Golapganj upazila in Sylhet during January to July 2018. Focus Group Discussion (FGD) was conducted to validate the information and collected data were analyzed using SPSS statistical software. A total of 86 plant species have been found, in which 34 are fruit species, 4 are woods, 29 are vegetables, 12 are herbal, and 7 are spices. Of them, Kanthal (*Artocarpus heterophyllus)* was the most dominant (85%) species. There were 32 recorded production activities, with *Oryza sativa, Psidium guajava*, vegetables, and *Areca catechu* being the major ones (>70%) and Piper betle, *Garcinia pedunculata, Moringa oleifera, Piper nigrum*, and *Apis mellifera* being the minor ones (14%). In addition, 21 agroforestry systems were documented (Agrosilviculture, silvoagriculture, silvoagripasture, apiculture with trees, silvopasture, and aquasilvoculture etc.). Homestead agroforestry was the mostly practiced agroforestry practice in the study site. According to respondents' perception near about 29 plants species increased in Golapgonj in which *Acacia*, *Psidium guajava*, *Areca catechu* and *Solanum lycopersicum* are the most. The highest Shannon-Weaver Diversity Index (H') was 0.94 in vegetable species while highest relative abundance was 44% in fruit and timber species. In the study region, various aspects of livelihood improvement were seen. 97% of them who responded firmly agreed that agroforestry techniques enhanced their health, nutrition, and lifestyle. So, there are huge scopes for transforming traditional agroforestry such as (Homestead agroforestry, pineapple based agroforestry) systems to modern agroforestry systems for improving farmer's livelihoods through higher production, income and environmental services which would eventually be facilitated to achieve SDGs.

Keywords: Agroforestry, Homestead, Livelihood, Golapganj, Sylhet

Introduction

Agroforestry combines agriculture with forestry with the goals of production, sustainability, and adaptability (Talucder and Ruba, 2023). Agroforestry can offer a stable ecological foundation for higher agricultural and livestock output, more reliable economic returns, and a wider range of social advantages. The research and development communities have recently shown an increased interest in agroforestry as a practical way to improve food security while also making a contribution to the adaptation and mitigation of climate change. This is due to ongoing food shortages, anticipated climate change, and rising costs of fossil fuel-based agricultural inputs. The combination of trees and agricultural crops, the amount of soil nutrients, the moisture conditions, and the pace of organic matter decomposition all have an impact on the optimal output of any agroforestry practice (Chundawat and Gautam 1993; Nair 1984). The provision of ecosystem services by agroforestry, such as carbon sequestration, biodiversity preservation, soil quality, and maintaining air and water quality, has drawn considerable attention in tropical and temperate regions of the world (Thevathasan and Gordon 2004; Jose 2009). More than 90% of biodiversity resources, particularly in tropical settings, are located in human-dominated landscapes (Garrity 2004).

Agroforestry techniques may prove to be a useful conservation strategy that will help to improve rural livelihoods while easing land-use strain (Kamrujjaman et al. 2023; Ruba and Talucder, 2023; Garrity 2004; Maroyi 2009). In many nations around the world, including Bangladesh, agroforestry has long been a crucial component of rural subsistence. Ineffective and primitive forest management techniques and ongoing deforestation have contributed to a lack of concern for ecosystem restoration (Muzaffar et al. 2011).

***Corresponding author:** MSA Talucder, Department of Agroforestry and Environmental Science, Sylhet Agricultural University, Sylhet-3100, Bangladesh. Email: talucdermsa.aes@sau.ac.bd*

In human-dominated settings, the significance of agroforestry (AF) systems in preserving species diversity might be crucial for biodiversity conservation (Anand et al. 2010). It is a climate smart landscape management system (Talucder and Ruba, 2023) which can promote to achieve at least 9 out of 17 Sustainable Development Goals especially SDG1, SDG2, SDG13 and SDG15 (Ruba and Talucder, 2023). Bangladesh contains 1,24,500 ha of inland moist deciduous Sal (*Shorea robusta)* forests, which widely distributed in the districts of Gazipur, Tangail, Mymenshingh, Dinajpur, Rangpur (Alam et al. 2010). It is crucial to look at the significance of AF for preserving species variety in a country like Bangladesh where less than 6% of the area is covered with forests (Talucder et al. 2016; Bardhan et al. 2012). Forests cover 12.8% of the total country area in Bangladesh (BFI, 2023). According to Chakraborty et al. (2015), the physical assets of farmers, which are a key measure of wealth, are a source of coping shocks in rural lives. It is also a reliable indicator of lifestyle. People with greater physical possessions are more socially significant than others. They discovered during their research that farmers who practice agroforestry have a greater number of physical assets than farmers who do not. According to Singha et. al., 2018, a total of 29 different agroforestry systems was recorded in the Kamalganj Upazila of Moulvibazar District in Sylhet. Agroforestry practices provide benefits such as nutrients, protection, soil erosion control and N-fixation. Thus it is necessary to strengthen knowledge on agroforestry for effective utilization of diversified agro ecosystem with suitable sophistical agroforestry approach to improve the livelihood of the rural community. The present study was designed to document the agroforestry's current state and plant biodiversity in the study area as well as to know the impacts of agroforestry on livelihood of the farmers' at Golapganj upazilla in Sylhet district.

Materials and Methods

Site selection

In the Sylhet district's Golapganj upazila, the study was carried out. There are 11 unions in Golapganj upazila (Figure 1). The Bagha union was chosen at random for the study out of the eleven unions.

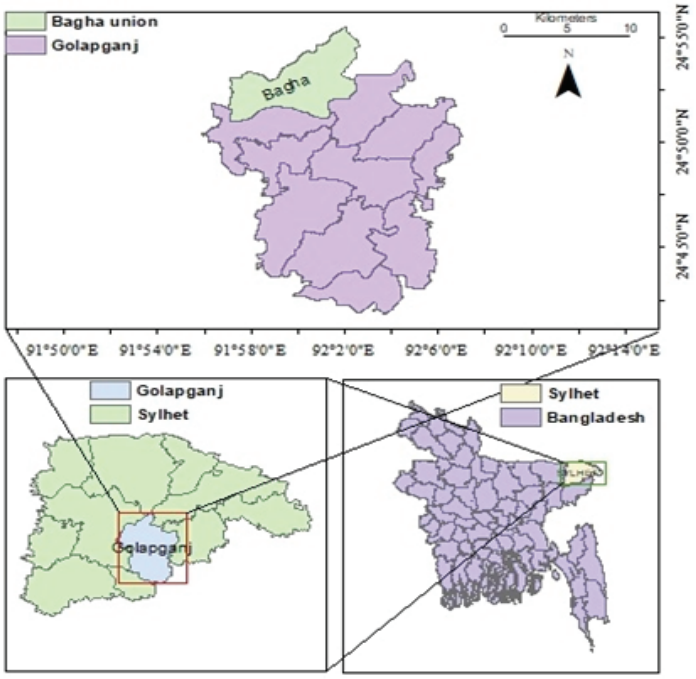

Figure 1: Study site

Sample number & data collection

Data were gathered in 2018 from January to July through personal interview from 60 randomly selected farmers from the village Gondamara and Turupbag of Bagha union. Face-to-face interviews were conducted as part of this study. An organized interview schedule was created with the study's goals in mind in order to gather pertinent information. Before the actual data gathering began, a pre-test survey was conducted. The necessary corrections, additions, alterations, and rearrangements were done in light of the pre-test experience. So, a final version of the interview schedule was created. A focus group discussion was conducted to confirm the data.

Indices

The formula for the Shannon-Weaver Diversity Index was employed in this instance (Yu Li et al. 1996):

$H' = -(\sum_1^n Pi \times \log Pi) / Log(n)$

Where, Pi is the proportion of the total number of entries belonging to the i^{th} class and n is the number of plant species and RA (relative abundance) percentage was determined by using following formula:

RA% = No. of species observed under a specific plant species/ No. of species observed under all plant species *100.

Results and Discussion

Respondents' socio-economic characteristics

Respondents were divided into three age groups based on the National Youth Policy: youth (18-35), middle (36-50), and old (above 50). The respondents' actual ages varied from 20 to 75, with a mean age of 45.02 and a standard deviation of 14.33. Begum (2012) observed results that were very comparable to the average age of the respondents in Tangail district's Gopalpur upazila, which was 42 years on average. According to the respondents' year of schooling, the respondents' education level was divided into 4 types, namely, illiterate (0), primary (1–5), secondary (6–10), and higher studies and above (>11). The respondents' educational levels ranged from zero to honors, with a mean of 5.42 and a standard deviation of 3.82. The respondents were divided into three groups: small families (fewer than five), medium families (five to eight), and large families (more than eight). The findings indicated that average family size of the study area (6.86) was greater than the national average which is 4.85 (BBS, 2015).

According to their farm area, respondents were divided into 4 class: landless and marginal (<0.21 ha), small (0.21–1.0 ha), medium (1.1-3.0 ha), and large (>3.0 ha). The average area of farm of the farmers was 2.11 acre which is greater than average farm size (0.59 acre) of farmers of Bangladesh according to FAO, 2015. According to their family's annual income, the respondents were divided into 3 class: low income (up to Tk. 1, 00,000), medium income (Tk. 1, 01,000 to 2, 00,000), and high income (above Tk. 2, 01,000). The respondents' family income ranged between BDT 24,000 and 10, 80,000, with a mean of 2, 72,000 and a standard deviation of 293.07. The respondents' distances from their homes to the nearest market and the nearest road were divided into three categories: close (less than 1 km), moderate (between 1 and 2 km), and far (more than 2 km). The respondents' mean distance from house to the nearest market was 1.98 km, with a standard deviation of 0.67 and a range of 0.5 to 5.0 km. The respondents' mean home-to-road distance was 0.76 km, while the standard deviation was 0.58 km, ranging from 0.5 to 3.0 km.

Table 1 Socioeconomic characteristics of the respondents'

Domain	Unit	Range of observation	Mean	SD
Age	Year	20-75	45.02	14.33
Level of education	Year of schooling	0-16	5.42	3.82
Family member	Number	2-21	6.86	3.33
Farm area	Acre	0-4.5	2.11	4.18
Family income	ThousandTk./year	24-1080	272.1	293.07
Distance from home to local market	Km	0.5-5.0	1.98	0.67
Distance from home to road	Km	0.5-3.0	0.76	0.58

Various agroforestry combinations practiced in the study area

About 21 distinct extant agroforestry systems were discovered in the study region (Table 2). Six separate sorts of agroforestry systems—silvoagriculture, agrosilviculture, silvoagripasture, apiculture with trees, silvopasture, and aquasilvoculture were identified in the Sylhet district's Golapganj. The majority of respondents in the area claimed to engage in silvoagriculture. Ten silvoagriculture, six agrosilviculture, and two silvoagripasture techniques were seen in the study area.

Table 2 Existing agroforestry systems practiced in the study area

SI No.	Combination of components	Agroforestry systems
01	Acacia –Brinjal – Indian hog plum	Silvoagriculture
02	Arjuna – Potato – Radish –Adalebu	Silvoagriculture
03	Banana- Hog plum – Indian grey frankolin	Agrosilviculture
04	Black pepper -Jackfruit –Sweet potato	Agrosilviculture
05	Sugarcane –Mangium –Olive	Agrosilviculture
06	Chamkathal–Ladies finger– Malabar spinach	Silvoagriculture
07	Lemon –Wood apple –Katalebu – Amaranth	Agrosilviculture
08	Jackfruit – Cucumber – Turkey	Silvoagripasture/Poultry-farm-forestry
09	Mango – Cattle – Ber	Silvopasture
10	Guava – Papaya – Tomato – Indian lilac	Agrosilviculture
11	Jackfruit –Litchi –Burmese grape – Wild orange	Silvoagriculture
12	Guava–Orange – Jara lemon – Indian persimmon	Agrosilviculture
13	Tamarind- Olive- Pineapple – Bottle gourd	Silvoagriculture
14	Jackfruit – Mango – Broccoli –Capsicum	Silvoagriculture
15	Apiculture – Ber- Blackberry- Indian pennywort	Apiculture with trees
16	Aquaculture- Palm – Betelnut	Aquasilvoculture
17	Coconut – Bottle gourd – Indian grey frankolin	Silvoagripasture/Poultry-farm-forestry
18	Indian lilac – Karanda – Brinjal – Holy basil	Silvoagriculture
19	Betel nut- Cauliflower	Silvoagriculture
20	Mango – Banana	Silvoagriculture
21	Coconut – Cabbage	Silvoagriculture

Different plant species cultivation

The most common species on homesteads was the jackfruit (85%). Country bean (68%) dominated the vegetable category. Among medicinal and spice species the dominant species were neem (42%) and bay leaf (52%), respectively. Yasmin et al. (2010) observed a similar type of medicinal species variety at Tangail and counted a total of 35 medicinal species in the homestead agroforestry.

Table 3 Distributions of responders by the type of major species they grow

Scientific Name			
Species	**Fruits**	**Frequency (%)**	**Relative Abundance (%)**
Jackfruit	*Artocarpus heterophyllus*	85	10
Banana	*Musa paradisiaca*	67	8
Coconut	*Cocos nucifera*	62	7
Jujubi	*Zizipus mauritiana*	50	6
Hog plum	*Spondias pinnata*	45	5
Vegetables			
Country bean	*Lablab purpureus*	68	9
Sweet gourd	*Cucurbita maxima*	58	8
Tomato	*Lycopersicon esculentum*	47	6
Bottle gourd	*Lagenaria siceraria*	47	6
Ridge gourd	*Luffa acutangula*	43	6
Medicinal species			
Neem	*Azadirachta indica*	42	25
Khude Thankuni	*Centella asiatica*	37	22
Haritaki	*Terminalia chebula*	25	15
Tulsi	*Ocimum sanctum*	15	9
Chengpichoil	Local *sp.*	15	9
Spices			
Bay leaf	*Cinnamomum tamala*	52	25
Green chili	*Capsicum frutescens*	50	24
Bombay chili	*Capsicum chinense*	42	20
Coriander leaf	*Coriandrum sativum*	38	18
Cardamom	*Elettaria cardamomum*	15	7

New varieties of trees and crops

It was found that there has been an increase in the cultivation of 15 crop species (HYV tomato, sweet gourd, HYV ridge gourd, HYV cucumber, khira, goyalgadda shim, diamond potato, gourd, HYV okra, capsicum, broccoli, BT brinjal, kucha and cabbage) in Golapganj. Additionally, it was found that the cultivation of 14 different tree species (Mangium, guava, betel nut, eucalyptus, lambu, mahogony, jackfruit, jujubi, kodom, litchi, rain tree, coconut, acacia, and mango) has grown in the research area. They began to plant these new crop and tree species about five years ago since they were interested in the advantages of agroforestry and plantation systems at the time. They had previously left the land fallow.

Table 4 The respondents' distribution according to the types of newly planted crops and trees

Common name			
Crops	**Scientific name**	**Frequency (%)**	**RA (%)**
Tomato	*Lycopersicon esculentum*	82	25
Sweet gourd	*Cucurbita maxima*	50	15
French bean	*Phaseolus vulgaris*	45	14
HYV Ridge gourd	*Luffa acutangula*	23	7
HYV Cucumber	*Cucumis sativus*	23	7
Trees			
Mangium	*Acacia mangium*	85	18
Guava	*Psidium guajava*	67	14
Betel nut	*Areca catechu*	63	14
Eucalyptus	*Eucalyptus camaldulensis*	23	5
Lambu	*Khaya anthotheca*	23	5

Shannon-Weaver Diversity Index (SWDI) of different agroforestry practices

The diversity of plant species that are now present in the research area was calculated using the Shannon-Weaver Diversity Index (H'). The H' is a straightforward approach for assessing the variety of plants. The H' scales from 0 to 1, with 1 denoting the greatest diversity and 0 denoting a community with a single species. The higher the value of H', the higher the diversity of species in a particular community. The lower the value of H', the lower the diversity. In the Sylhet district's Golapganj, many farming techniques were used. Homestead species, medicines, vegetables, and spices were among them, and they displayed SWDIs of 0.86, 0.83, 0.94, and 0.87, respectively. Homestead species, vegetables, medicinals, and spices all had relative abundances of 44%, 34%, 14%, and 8%, respectively.

Table 5 Shannon-Weaver Diversity Index (SWDI) of various plants growing in Golapganj

Cultivation Practices	SWDI	RA (%)
Homestead species	0.86	44
Medicinals	0.83	14
Vegetables	0.94	34
Spices	0.87	8

Benefits and drawbacks of agroforestry practices in Golapganj upazila

Agroforestry is defined by ICRAF (International Centre for Research in Agroforestry) (2013) as an agricultural system that incorporates trees, plants, and animals on a farm and provides a number of benefits. The respondents were given a Likert scale (5-point) to rate how much agroforestry had improved their quality of life. 5 points are defined as follows: 5 means "strongly agree," 4 means "agree," 3 means "not sure," 2 means "don't agree," and 1 means "not at all agree."

At this point, 57% of farmers were in agreement that these measures increased yield. However, several farmers who were accustomed to monocultures showed little interest in it. Some farmers were unaware of the concept of microclimate. However, the majority of them strongly agreed that agroforestry practices improve microclimate at a rate that is acceptable. The soil fertility of an agroforestry system is significantly impacted. The best soil nutrient utilization is provided by this approach. The utilization of tree residue-derived manure has the potential to mitigate the reliance on synthetic fertilizers, thereby contributing to the preservation of soil health. The majority of farmers felt that agroforestry practices lessen crop loss since if one crop fails, another is still available to offset the loss. Inadequate agroforestry extension, poor project design or management (such as top-down management approaches and the use of food incentives), smallholders' financial constraints, and more significant policy issues were the main barriers impeding increased agroforestry adoption. Recommendations are made to enhance project management and design, as well as to solve the financial and policy restrictions (Fischer and Vasseur 2002).

Table 6 Respondents' perception regarding advantages and disadvantages of agroforestry practices

Statements	Degree of agreement (%)				
	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Advantages					
Increasing production	57	10	7	18	8
Improving microclimate	58	22	18	2	-
Reducing chemical fertilizer	43	18	6	33	-
Reducing crop loss	47	28	13	7	5
Reducing weed infestation	42	23	8	25	2
Disadvantages					
Increasing competition	40	32	15	13	-
Problems in management	38	33	12	17	-
Pruning material harms crop	45	18	10	27	-

Utilizing agroforestry techniques to improve livelihood and food security

There is little doubt that agroforestry products significantly improve livelihoods, especially in light of the numerous advantages of agroforestry that have been highlighted. The farmers were given a 5-point Likert scale to rate how much agroforestry had improved their quality of life. Farmers expressed the opinion that agroforestry methods greatly influence the nutritional needs of their families. Numerous fruit trees on homesteads offer both food and wood. Tree species also cool the climate and offer shade. As a result, they are able to meet their nutritional needs and live in a healthy environment. They have enough resources to live a good life. They can now provide for their family's needs and educate their kids. Farmers claim that agroforestry practices improved the relationship between producers and consumers. Farmers in the study area only grow unprocessed goods. They don't further process it to create value. For them, value addition is a novel concept, and they approach it pretty riskily. Additionally, there is not enough of a processing industry to increase the value of the commodity. There isn't a lot of proper marketing infrastructure accessible. Farmers, however, appeared to believe that a correct system would be more advantageous for them and allow them to maximize their production's profit. The term "germplasm introduction" is foreign to them.

Table 7 Perceptions of respondents on improved livelihood and food security through agroforestry techniques

Statements	Degree of agreement (%)				
	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Health & nutritional improvement	97	3	-	-	-
Life style improvement	97	3	-	-	-
Consumer and producer interactions	87	13	-	-	-
Value addition	-	-	-	100	-
Development of marketing	83	17	-	-	-
Introduction of Germplasm	-	-	100	-	-
Ability to adapt on dry land	47	53	-	-	-

Participation of farmers in different agroforestry practices

Farmers were involved in a variety of production practices, including homestead agroforestry, livestock, field crop production, roadside agroforestry, citrus-based agroforestry, aquaforestry, pineapple-based agroforestry, cropland agroforestry, betel leaf agroforestry, black pepper-based agroforestry, drumstick production, apiculture, agarwood plantations, and others. The majority of respondents worked in the production of rice (100%), vegetables (85%), and animals (cattle, pasture, chicken, turkey, titir etc.), among other things. 50% of respondents reported growing jackfruit, 40% cultivating medicinal plants, 35% cultivating crop land AGF, and 30% cultivating lemons. Less than 20% of respondents engaged in the cultivation of the pummelo, the serpent chilli (nagamorich), the litchi, and the fodder industry. However, because Sylhet district is suitable for citrus production, berry, toikor, and satkora are ignored and underutilized species with vast study potential. In the Pabna district, Rashid et al. (2007) discovered eleven different traditional agroforestry practices. The distribution of respondents by how much they participated in production activities is shown Figure 2.

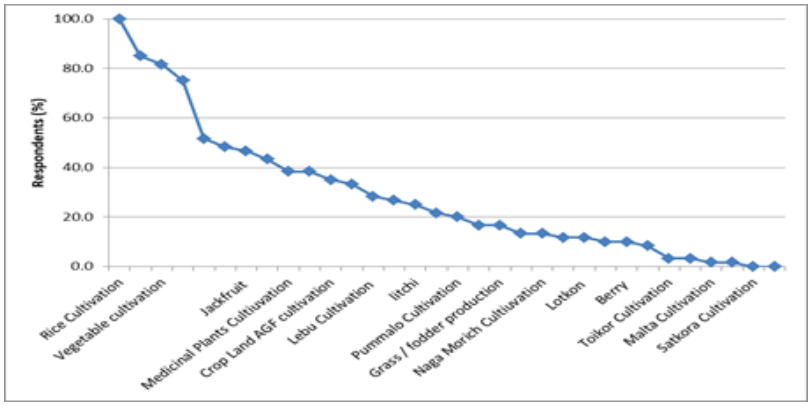

Figure 2 Distribution of the respondents depending on their involvement in production activities

Existing agroforestry techniques

The research area contained some agroforestry operations. Home gardens were cited as the most popular agroforestry practices in the Golapganj upazila by the majority of respondents (92%) in the survey. Agrosilviculture and aquaforestry, in the opinion of the respondents, accounted for around 72% of the total. According to 68% of respondents, silviculture and intercropping with firewood are both practices. 65% of respondents use alley cropping. About 48% engaged in apiculture using fruit trees, while 50% planted protein-rich tree fodder. The distribution of responders based on current agroforestry practices is shown in the Figure 3.

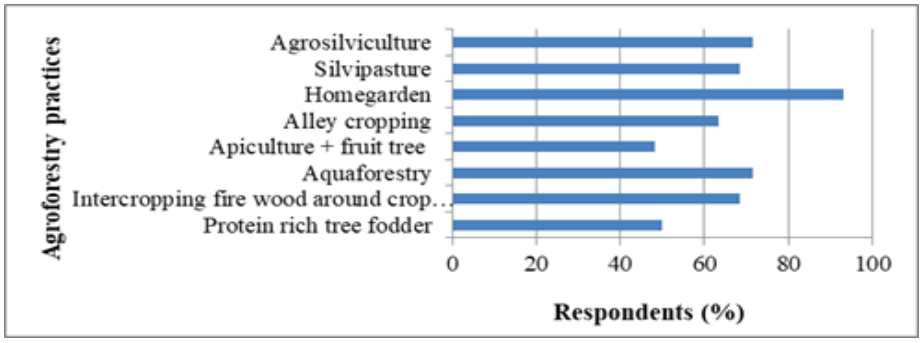

Figure 3 Distribution of the respondents depending on existing agroforestry practices

Conclusion

The research area encompasses several agroforestry operations. The majority of participants engaged in home gardening, with agrisilviculture and silvopasture being the subsequent practices seen. The presence of tree species in this region can be attributed to the favorable geographical and climatic conditions. Fruit trees, due to their ability to fulfill nutritional requirements and provide timber resources, were predominantly chosen as the primary species for residential cultivation. The majority of participants possessed livestock such as cattle, poultry, and turkeys, which were raised in pastures. This practice significantly contributed to enhancing nutrition and food security. They were able to satisfy their agroforestry farming requirements for sustenance and nourishment with a high degree of self-sufficiency. The use of agroforestry techniques in this specific region, utilizing the existing species, holds the potential to yield significant benefits and enhance the well-being of the local population from a scientific standpoint. Government entities, non-governmental organizations (NGOs), and various social and environmental groups possess the potential to assist farmers in recognizing the positive impacts of agroforestry practices on their livelihoods, nutrition and food security, and climate change mitigation.

Acknowledgements

The authors express their sincere thanks to the Bangladesh Agricultural Research Council (BARC) for providing financial support for the survey work through the National Agricultural Technology Project-2 (ID:439). The first author is also gratefully acknowledge the National Science and Technology (NST) fellowship as her honorarium by the Ministry of National Science & Technology (MoST), Government of the People's Republic of Bangladesh.

References

Alam M, Furukawa Y, Harada K. 2010. Agroforestry as a sustainable land use option in degraded tropical forests: a study from Bangladesh. *Environment, Development and Sustainability*, 12(2): 147−158.

Anand MO, Krishnaswamy J, Kumar A, Bali A. 2010. Sustaining biodiversity conservation in human-modified landscapes in the Western Ghats: remnant forests matter.

Bardhan S, Jose S, Biswas S, Kabir K, Rogers W. 2012. Homegarden agroforestry systems: an intermediary for biodiversity conservation in Bangladesh. *Agroforestry Systems*, 85:29–34. DOI 10.1007/s10457-012-9515-7

BBS (Bangladesh Bureau of Statistics). 2015. Statistical Yearbook of Bangladesh Stat. Div., Minist. Plan, Govt. People's Repub. Bangladesh, Dhaka.

Begum M. 2012. Study on Homestead Agroforestry and Plant Diversity in Gopalpur Upazila of Tangail District. MS thesis Department of Agroforestry, Bangladesh agricultural university, Mymensingh. Pp.79.

Chakraborty M, Haider MZ, Rahaman MM 2015. Socio-Economic Impact of Cropland Agroforestry: Evidence from Jessore District of Bangladesh. *International journal of research in agriculture and forestry,* 2(1): 11-20.

Chundawat BS, Gautam SK. 1993. *A Textbook of Agroforestry*. New Delhi: Oxford and IBH Publisher, pp. 64−69.

FAO (Food and Agriculture Organisation of the United Nations). 2015. The economic lives of smallholder farmers: An analysis based on household data from nine countries. pp. 5. FAO, Rome.

Fischer A, Vasseur L. 2002. Smallholder perceptions of agroforestry projects in Panama. *Agroforestry Systems* 54 103–113.

Garrity DP. 2004. Agroforestry and the achievement of the millennium development goals. Agroforestry System 61:5–17.

International Centre for Research in Agroforestry (ICRAF). 2013. Strategy 2013- 2022. IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III

Jose S. 2009. Agroforestry for ecosystem services and environmental benefits: an overview. Agroforestry System 76:1–10.

Kamrujjaman M, Talucder MSA, Ruba UB, Robi MAS, Rahman A, Alom S, Uddin MS. 2023. First Report on Homestead-Based Black Pepper (*Piper nigrum*) Gardening at Jaintiapur of Sylhet District in Bangladesh. *European Journal of Agriculture and Food Sciences*, 5(2):27-34. Available from: https://www.ejfood.org/index.php/ejfood/article/view/644

Maroyi A. 2009. Traditional homegardens and rural livelihoods in Nhema, Zimbabwe: a sustainable agroforestry system. *International Journal of Sustainable Development and World Ecology* 16:1–8.

Muzaffar SB et al. 2011. The endangered forests of Bangladesh: why the process of implementation of the convention on biological diversity is not working. Biodiversity Conservation 20:1587–1601.

Nair PKR. 1984. The role of trees in soil productivity and protection. In: P.K.R. Nair (ed), *Agroforestry Systems in the Tropics*. London: Kluwer Academic Publishers, pp. 567−589.

Rashid MH, Islam KK, Mondol MA, Pervin MJ. 2007. Impact of traditional homestead Agroforestry on the livelihood of the respondents in northern Bangladesh., *Journal of Agroforestry and Environment.* 2(1): 11-14.

Ruba UB, Talucder MSA. 2023. Potentiality of homestead agroforestry for achieving sustainable development goals: Bangladesh perspectives. *Heliyon*, 9(3): e14541. https://doi.org/10.1016/j.heliyon.2023.e14541

Sadaat MN 2007. A study on the homestead agroforestry of three selected unions of Gobindagonj upazila in Gaibandha district.

Singha S, Uddin MS, Banik SC, Kasem MA. 2018. Homestead Agroforestry Systems Practiced at Kamalganj Upazila of Moulvibazar District in Bangladesh. *Asian Journal of Research in Agriculture and Forestry,* 2(2): 1-8.

Talucder MSA, Haque MM and Saha D. 2016. Development of Agar (*Aquilaria malaccensis*) cultivation, propagation technique and its potentiality as agroforestry component in Bangladesh: a review. *Journal of Sylhet Agricultural Univ*ersity. 3(2):149-157.

Talucder MSA, Ruba UB. 2023. The role of agroforestry approach as a potential tool for attaining climate smart agriculture framework: Bangladesh perspectives. *Russian Journal of Agricultural and Socio-Economic Sciences*, 3(135): 88-103. https://doi.org/10.18551/rjoas.2023-03.11

The Bangladesh Forest Inventory: Results at a glance. 2023.

Thevathasan NV, Gordon AM. 2004. Ecology of tree intercropping systems in the North temperate region: experience from southern Ontario, Canada. Agroforestry System 61:257– 268.

Yasmin R, Wadud MA, Mandol MMA, Sharif MO. 2010. Tree diversity in the homestead and cropland areas of Madhupur Upazila Under Tangail District. *Journal of Agroforestry and Environment* 4(1): 89-92.