Geografia-Malaysian Journal of Society and Space 20 issue 4 (115-130)
 https://doi.org/10.17576/geo-2024-2004-09

Exploring farmers' perspectives on agroforestry practices in Rangamati Hill tracts of Bangladesh

Setu Chakma[1], Mithun Kumar Ghosh[2], Md. Mahbub Alam[2], Ajnabi Sultana[3], Eco Talukder[4], Netui Chakma[5]

[1]Rangamati Science and Technology University, Jhagrabil
[2]EXIM Bank Agricultural University Bangladesh
[3]Coordinator-agriculture, World Vision Bangladesh
[4]University of Chittagong
[5]Mawlana Bhashani Science and Technology University

Correspondence: Mithun Kumar Ghosh (mithunbsmrau88@yahoo.com)

Received: 12 May 2024; Accepted: 28 October 2024; Published: 29 November 2024

Abstract

Agroforestry has been a vital component of the livelihoods of hill communities in Bangladesh, supplying households with food and energy, generating income, and helping to protect the environment. This study was carried out in the hilly regions of the Rangamati district for examining farmers' perceptions of agroforestry and researching the driving forces behind the adoption of agroforestry methods and the difficulties. According to the survey results, majority of the respondents were from the Chakma community, predominantly male, in their middle age, had a secondary level of education, had a medium annual income with medium sized land, more than 20 years of average farming experience, less training and occasional cosmopolitan behavior and extension media contact. Most of the respondents showed a low level of understanding about agroforestry, they prefer cropland and fruit-based agroforestry systems with mostly planted mango trees. The most popular choice was the combination of fruit and vegetable production with tree species. Farmers also denote that they have a lack of government support which is the top-ranked problem followed by a lack of capital, inadequate training, and insufficient transport facilities. According to a correlation analysis, farmers' annual income, educational qualification, training, extension contacts, innovativeness were significantly positive with their knowledge of agroforestry systems. In conclusion, agroforestry practices could become more prevalent and adopted in this hilly region of Bangladesh with more government support on the training facilities, transport, technology, and knowledge, particularly from the Department of Agricultural Extension.

Keywords: Adoption, agroforestry, farmer perspectives, Rangamati Hill Tracts, sustainable livelihoods

Introduction

Bangladesh is a predominantly agricultural country and very densely populated (both in number and in density) (Ghosh et al., 2021; Hasan et al., 2017; Hasan & Sultana 2011) with the sector accounting for 13.07% of the GDP of the country and about 39.46% of the total workforce (BBS, 2018). The area of the country is very small and has a huge population, making it one of the most

densely populated countries in the world with an annual growth rate of 1.37% (BBS, 2017). Rapid population growth has created new pressures on limited resources such as agriculture, forests and land. Bangladesh's forest cover is one of the lowest at 11% and at the same time its deforestation rate is the highest at 3.3% per year of any country in the world (Gain, 1995; FAO, 2010; Rahman et al., 2010). There is an urgent need to find the best possible way to produce more agricultural crops and forest products using these scarce resources to meet the demands of a growing population. The current land use system in Bangladesh, which divides land between agriculture and forestry, will not be sufficient to meet the needs of the rural population (Hanif et al., 2015). To meet the needs of the growing population of Bangladesh, it is crucial to find the most efficient technique to produce more agricultural crops and forest products while using limited resources (Saha et al., 2018). Therefore, agroforestry is preferred over multiple cropping because it can generate income from agricultural produce as well as the sale of trees, enabling it to meet the diverse needs of rural people (Rahman et al., 2012).

The hilly area constitutes about 12% of the total territory, located mainly in the eastern and south-eastern part of Bangladesh, characterized by alternating beds of poorly consolidated sand and shales which form the basis for the formation of complex mixtures of deep and shallow soils (Zakaria & Majumder, 2019; Hossain, 2011). The high hills ranged from 200-1000m and the lowest hills from 15-200m above mean sea level (Hossain et al., 2017). The Chittagong Hill Tracts (CHT) comprise 70% of the hilly areas of Bangladesh and cover 13,184 km2 (10% of the total area), 90% of which are sloping (Hossain et al., 2017). The area is mild to very steep, with a gradient ranging from 15% to over 70%, often breaking or ending in cliffs (SRDI, 2018). Agriculture is the main source of income for most mountain people. Agricultural activities include tilling the land, shifting cultivation, cultivation of orchards, wage labor, timber production, livestock and poultry raising, and free fishing. More than 35 crop species are grown annually in hilly areas (Ahammad & Stacey, 2016). Rangamati is a district in southeastern Bangladesh. It is part of the Chittagong Hill Tracts and Rangamati Town serves as the district headquarters. Rangamati is the largest district in the country in terms of area. The area of the district is 6116 km^2 of which 1292 km^2 of rivers and 4825 km^2 of forest vegetation.

Agroforestry, the purposeful integration of trees or shrubs with crops and/or livestock at the plot, farm, and/or landscape scale, is one potential climate change adaptation strategy to increase the resilience of farmers and agricultural systems against climate risk, providing a range of biophysical and socioeconomic benefits (Quandt et al., 2017; Rosenstock et al., 2015). As highlighted by recent Intergovernmental Panel on Climate Change (IPCC) reports (Kerr et al., 2022), agroforestry is a promising agroecological approach to climate change adaptation because of the multitude of cobenefits that many agroforestry systems provide in addition to climate change adaptation, including synergies with climate change mitigation through carbon sequestration, enhanced food security and income opportunities, the provisioning of ecosystem services, and biodiversity conservation (Noordwijk et al., 2021; Meybeck et al., 2021)

It is evident that agroforestry can improve ecosystem services in tropical and hilly agricultural environments (Jose, 2009). Like any other agricultural innovation, agroforestry will only be incorporated into farming systems by farmers if they believe it will best serve their goals and make use of the resources at hand (Pannell et al., 2006). Adoption will thus be significantly influenced by farmers' attitudes about agroforestry (Frey et al., 2012; Meijer et al., 2014). Finding the agroforestry systems that best suit farmers' needs and directing extension efforts in that direction will be made easier by having a better understanding of how farmers weigh the benefits and downsides of various systems.

Farmers' opinions of agricultural advances are known to be influenced by farm and household variables (Meijer et al., 2014; Pannell et al., 2006). In order to look for any discrepancies in the opinions of each farmer group regarding agroforestry compared to traditional land-use systems, we are interested in comparing their perspectives. Nonetheless, a multitude of elements impact farmers' choices to implement enhanced and inventive farming approaches (Nazu et al., 2021). Different incentives, farmers' sociodemographic characteristics, institutional procedures, and policies may be established to support the adoption of agroforestry, depending on the location's unique circumstances (Nkamleu & Manyong, 2005). Regretfully, there is a lack of information regarding the factors that influence the adoption of agroforestry in Bangladesh, which makes it challenging for policymakers to implement successful interventions. Agroforestry adoption has been the subject of few research carried out in Bangladesh (Rasul & Thapa, 2006; Rahman et al., 2012; Sharmin & Rabbi, 2016; Saha et al., 2018); however, none of these studies evaluated the problem of agroforestry's acceptance determinant and its prospects in detail. In light of these issues, the current study looks at farmer-oriented factors that affect the adoption of agroforestry practices.

Agricultural forestry has attracted the attention of scientists and development planners to improve traditional agricultural methods, harmonize food production and environmental conditions in the region, the implementation of land use, taking into account socio-economic considerations. However, most of the research on agroforestry has been conducted from a biophysical perspective, but the analysis of farmers' attitudes towards agroforestry is important in increasing the acceptance rate among farmers.

While extensive research has been conducted on the biophysical aspects of agroforestry, there is a notable gap in understanding the socio-economic factors that influence farmers' adoption of these practices. The attitudes and perceptions of farmers are critical determinants of the acceptance and success of agroforestry systems. The present study aims to fill this gap by analyzing farmers' perceptions of agroforestry practices in the Rangamati district. Additionally, the study seeks to identify the motivational factors that influence the adoption of agroforestry and to explore the challenges faced by farmers in implementing these practices. By addressing these objectives, the research aims to contribute to the development of more effective strategies for promoting agroforestry in similar hilly regions.

Therefore, the present study is conducted in a hilly area of the Rangamati district with the specific objectives of analyzing farmers' perception of agroforestry practices and studying the motivational factors that influence the adoption of agroforestry practices. The study also sought to identify the problems farmers face in adopting agroforestry practices in the study area.

Materials and Methods

Research design

The study followed a quantitative survey approach as its primary research design. Quantitative surveys are chosen for their ability to systematically collect numerical data from a large sample size, facilitating statistical analysis to draw meaningful conclusions and identify patterns or correlations within the data.

Location of the study

The study was conducted in Rangamati, located in Chittagong Division, Bangladesh, spanning latitudes 22°27' to 23°44'N and longitudes 91°56' to 92°33'E. Rangamati is unique for being the only district in Bangladesh that borders two countries, India and Myanmar, and is surrounded by various districts and states. Covering an area of 6116 km², with 1292 km² of rivers and 4825 km² of forests, Rangamati's diverse geography includes international borders, riverine landscapes, and extensive forest areas.

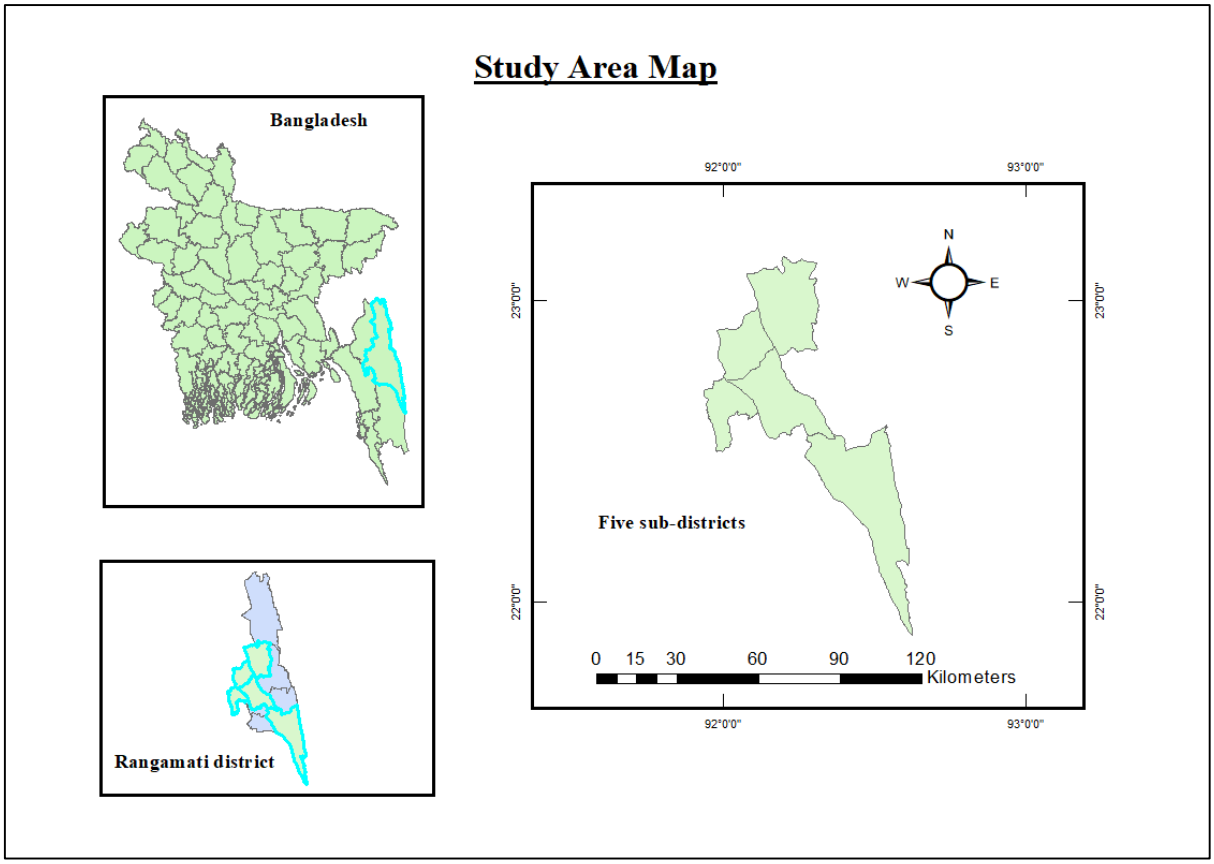

Figure 1. Location of the study

Sampling

Rangamati is comprised of 10 Upazilas, 50 union parishads and 1347 villages. This district is purposively chosen as the first sampling unit. In this study, Kaokhali, Langodu, Baghaichari, Naniachar, Rangamati Sadar, these five upazila were randomly selected as the second sampling unit, and then two unions from each of the five upazila were randomly selected as the third sampling unit. From each union, 25 respondents were selected using snowball sampling and a total of 250 respondents were contacted for this survey.

Data collection

Two main sources were used to collect the data, these were primary and secondary. Questionnaires, interviews and field observation methods were used to gather detailed information on respondents' perceptions and demographics. A pre-structured questionnaire was used to collect data on primary data from respondents during a face-to-face interview from 15 January, 2022 to 30 March, 2022. Secondary data sources were from journal publications, government agencies, consultants, local leaders, published and unpublished reports, internet browsing, etc.

Variables and their measurement

The study measured independent variables including farmers age, their family size, farmers educational qualification, farmer category, land type, family annual income, farming experience, income source, cosmopolitan behavior, training on agriculture, and extension media communication. Age was determined by the respondent's actual years. Family size included all permanent members living together. Education was categorized based on schooling years into illiterate, primary, secondary, higher secondary, and tertiary levels. Annual income was calculated in Bangladeshi Taka (BDT) from all family earnings. Farmers were classified by land size into small, medium, and large, and land types were categorized as own, shared, leased, or other. Farming experience was divided into six categories based on years of cultivation. Farmers Cosmopolitan behavior, the extent of social and external interaction, was rated on a four-point scale. Extension contact measured the respondent's engagement with agricultural extension agents, scored by the frequency of interaction. Training was simply noted as yes or no.

The study's dependent variable was knowledge of farmers about agroforestry system. This method was used by Jaganathan et al. (2012) to calculate the knowledge level index was also used to evaluate the farmers' level of knowledge. This is provided by the formula below:

$$\text{Knowledge Index} = \frac{(\text{Respondents Total knowledge Score})}{\text{Total Possible Knowledge Score}} \times 100$$

Following that, the respondents were divided into four groups depending on their obtained knowledge score: High, Average, Low, and Very Low level of knowledge. A set of 10 questions was made to evaluate farmers knowledge level on agroforestry practices. A score of 2 was assigned for each correct answer and 1 was for partial and 0 for incorrect. Respondents who got less than 40% number, their knowledge level was considered to be very low and those who got number between 40%-59% was considered to have a low knowledge level. Participants who scored between 60 and 79 % were thought to have average knowledge. The farmers who received an 80% score were regarded as having a high level of knowledge according to Ghosh et. al (2023).

To identify problems in hill area agroforestry, a 3-point Likert scale with 10 statements was used. Respondents rated their agreement as "mostly agree," "somewhat agree," or "do not agree," with scores of 3, 2, and 1, respectively, for positive statements. The statements were then ranked chronologically based on their total scores.

Data analysis

Data analysis was performed using SPSS version 26.0 and Microsoft Excel. Respondents were categorized to analyze various factors. Basic statistics and regression analysis were used to understand descriptive data and the impact of sociodemographic characteristics on adoption.

Results and discussion

Respondents' socio-demographic characteristics

The study found most respondents (74%) were middle-aged (29-52 years), with a significant portion (44.8%) having secondary education. Families predominantly had 5-8 members (60.4%), with 98% of respondents being male. The Chakma community was the largest ethnic group among respondents. Farm size was mostly medium (2.5-7.4 acres) for 48.4% of participants. Land ownership was high at 90.4% for own land, and the average family annual income was TK 131,252, below the national per capita. Farming experience averaged 22.2 years, with 45.6% having over 22 years of experience. Half of the respondents occasionally contacted extension services, and 43.2% displayed occasional cosmopolitan behavior. Adoption rates showed 42.8% as early majority, taking 2-3 years to adopt new technologies. Agriculture was the main income source for 75.6%, and 70.8% did not receive agroforestry training (Table 1).

Table 1. Distribution of the respondents according to their socio demographic (n=250)

Variable	Categories	Frequencies	Percentage	Mean
Age (years)	Young (<29 years)	4	1.6	
	Middle (29 to 52 years)	185	74.0	48.59
	Old (>52 years)	61	24.4	
Educational qualification (Years of schooling)	Illiterate (0)	39	15.6	
	Primary (1 to 5)	79	31.5	
	Secondary (6 to 10)	112	44.8	6.28
	Higher Secondary (11-12)	18	7.2	
	Tertiary (>12)	2	0.8	
Family size (number)	Small (up to 4 members)	94	37.6	
	Medium (5-8 members)	151	60.4	4.96
	Large (>8 members)	5	2	
Gender	Male	245	98.0	
	Female	5	2.0	
Tribe	Muslim	82	33.6	-
	Hindu	2	0.8	
	Chakma	149	59.6	
	Marma	16	6.4	
	Others	1	0.4	
Land size	Small farmers (<.2.4acr)	116	46.4	-
	Medium farmers (2.5-7.4acr)	121	48.4	
	Large farmers (> 7.5 acr)	13	5.2	
Land ownership	Own	226	90.4	-
	Shared	19	7.6	
	Leased	2	0.8	
	Others	3	1.2	
Family Annual Income	Low (<80000.00 BDT)	87	34.8	

(BDT)	Medium (80001 to 300k BDT)	158	63.2	131252.32
	High (>300000 BDT)	2	2	
Farming experience (years)	<5 years	8	3.2	
	5-10 years	44	17.6	
	11-16 years	39	15.6	22.92
	17-22 years	45	18	
	>22 years	114	45.6	
Extension media contact	Frequently (1-2 time/month)	86	34.4	
	Occasionally (once/2 month)	125	50.0	
	Rarely (1-3 times/year)	39	15.6	
Cosmopolitan behavior	Frequently (once in a week)	79	31.6	
	Occasionally (once a month)	108	43.2	
	Rarely (Once in 6 months)	32	12.8	
	Never	31	12.4	
Innovativeness	Within 1 year of hearing	77	30.8	
	Within 2-3 year of hearing	107	42.8	
	Within 4-5 year of hearing	53	21.2	
	After 5 years of hearing	13	5.2	
Source of income	Agriculture	189	75.6	
	Business	22	8.8	
	Job	1	0.4	
	Others	38	15.2	
Training	Yes	73	29.2	
	No	177	70.8	

Moreover, about 78.8% of respondents were aware of agroforestry, but 26.2% were not. The majority (39.1%) held 40-59% of their land in agroforestry, with lesser portions having 20-39% and more than 80%. Most owned their land (90.4%), with smaller percentages sharing, leasing, or using public land. Income from agroforestry varied, with 50% earning over 30,000 BDT annually and an average income of 45,305.77 BDT. Information on agroforestry primarily came from mass media (42.1%), other farmers (29.4%), and neighbors (26.6%), with mobile apps and YouTube being popular sources.

Agroforestry practices in the study area

According to Figure 2, the majority of respondents (42.9% and 41.3%) reported adopting the cropland and fruit-based agroforestry systems, respectively. These systems involve the integration of tree cultivation with traditional crop production, emphasizing the coexistence and mutual benefits of trees and agricultural crops. The high prevalence of these two systems

© 2024, e-ISSN 2682-7727 https://doi.org/10.17576/geo-2024-2004-09

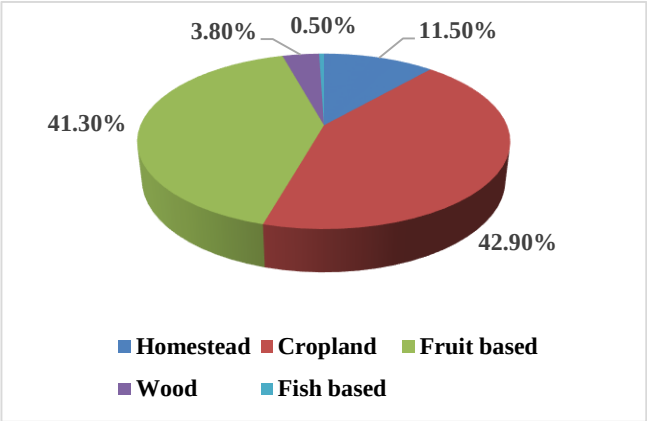

Figure 2. Distribution of the respondents according to type of agroforestry practices

suggests their popularity and suitability in the study area. Following cropland and fruit-based agroforestry, a smaller proportion of respondents (11.5%) adopted the homestead system. Homestead agroforestry involves the integration of trees within the household premises, providing multiple benefits such as food production, shade, and aesthetics. The adoption of this system highlights the importance of utilizing available space within residential areas for agroforestry practices.

A minority of respondents (3.8%) reported adopting the woodlot system, which primarily focuses on the cultivation of trees for timber or fuelwood production. This system may be suitable for areas with specific forestry objectives or for addressing the demand for wood-based products. Interestingly, only a small percentage (0.5%) of respondents reported adopting the fish-based agroforestry system. This system combines tree cultivation with fish farming, allowing for the integration of aquaculture and agroforestry practices. Its limited adoption suggests that it may be a relatively specialized and less prevalent approach in the study area.

In summary, the study revealed that cropland and fruit-based agroforestry systems were the most common practices in the study area, followed by the homestead system. Woodlot and fish-based agroforestry systems were adopted by a smaller proportion of respondents. These findings provide insights into the diversity of agroforestry practices and their suitability in the Rangamati district.

Prevalence of crops in the agroforestry systems

According to figure 3a, approximately 47% of farmers predominantly grew fruits within their agroforestry systems. This preference stemmed from both personal consumption and commercial sales, with mangoes being the most popular choice planted by 36.10% of respondents, followed closely by bananas at 24.80%, and litchis at 10.40% (figure 3b). About 27% engaged in cereal cultivation, a staple crop, while 21% focused on vegetables, vital for nutritional diversity and food security. Pulse crops, known for their high protein content, were cultivated by a smaller percentage (3%). The findings suggest that farmers prioritize fruit production for personal consumption and commercial purposes, while also acknowledging the importance of staple crops and vegetable cultivation.

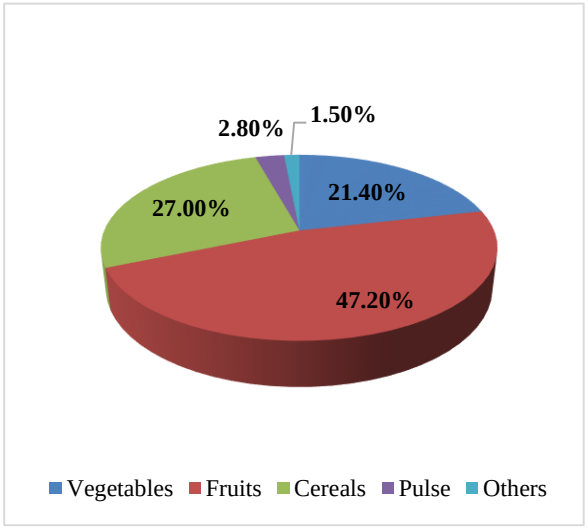

Figure 3a. Distribution of the respondents according to prevalence of cultivated crops

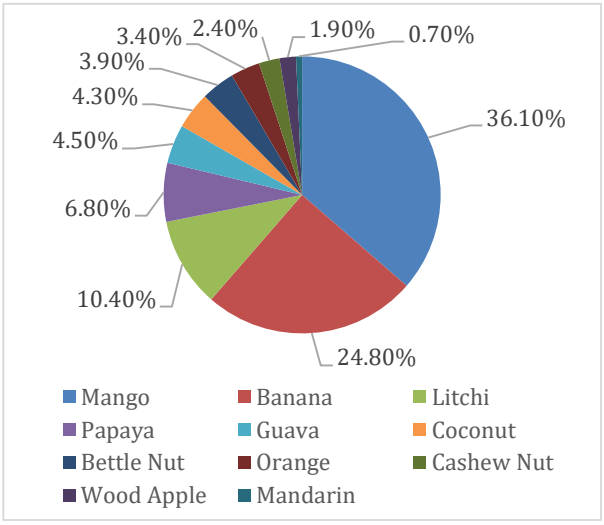

Figure 3b. Distribution of the respondents according to prevalence of cultivated Fruits

Prevalence of tree species in the agroforestry systems

Figure 4 reveals that among timber species, teak (Shegun) stands out significantly, with almost half (49.90%) of the trees planted belonging to this species, underscoring its commercial value and widespread cultivation in agroforestry setups. Conversely, the Year-leaf Acacia (Akashmoni) tree registers the lowest presence at a mere 0.20%. In terms of medicinal trees, Indian gooseberry (Amloki) takes the lead, with 15.7% of respondents reporting its cultivation, highlighting its significance for its medicinal properties. On the other hand, the Arjun tree trails behind with just 2.2% of respondents planting it. These findings emphasize the dominance of teak as a timber species, and the importance of Indian gooseberry as a medicinal tree in the agroforestry landscape.

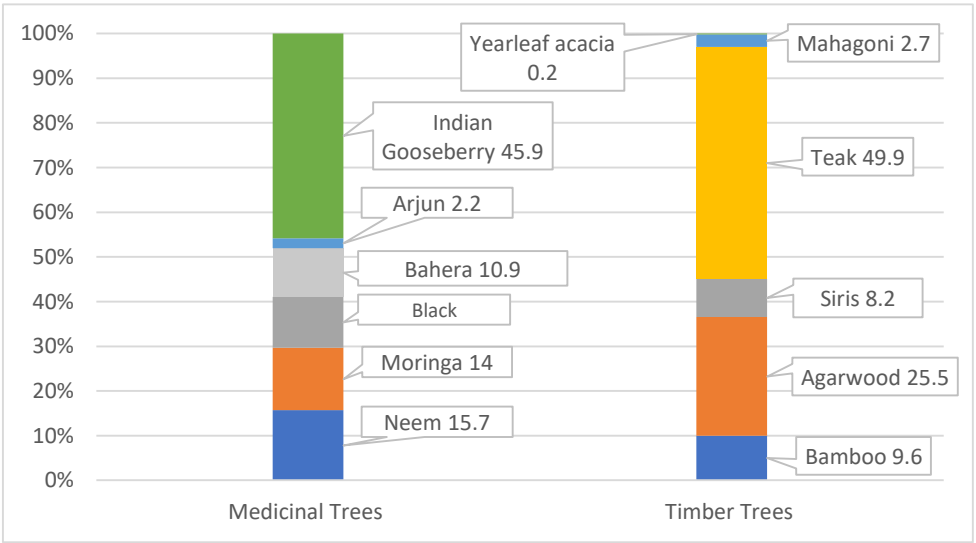

Figure 4. Distribution of the respondents according to prevalence of tree species in the agroforestry

Profitable crop-tree combination

It is evident from the figure 5 that combining fruit and vegetable production with tree species was the most economically profitable option, favored by 45.6% of respondents. Teak was the predominant tree species in the area, known for its commercial value. Combining fruit-bearing trees with other tree species was the second most popular choice, with approximately 21.4% of responses. Additionally, combinations of fruits with vegetables and tree species, as well as tree species with cereal crops, were perceived as profitable by 14% and 10% of respondents, respectively. However, combinations involving animal rearing and oilseed crops were considered less profitable by only 4.3% and 3.1% of respondents. Combinations with vegetables and other crops were deemed least profitable, with only 0.9% and 0.6% of respondents considering them viable.

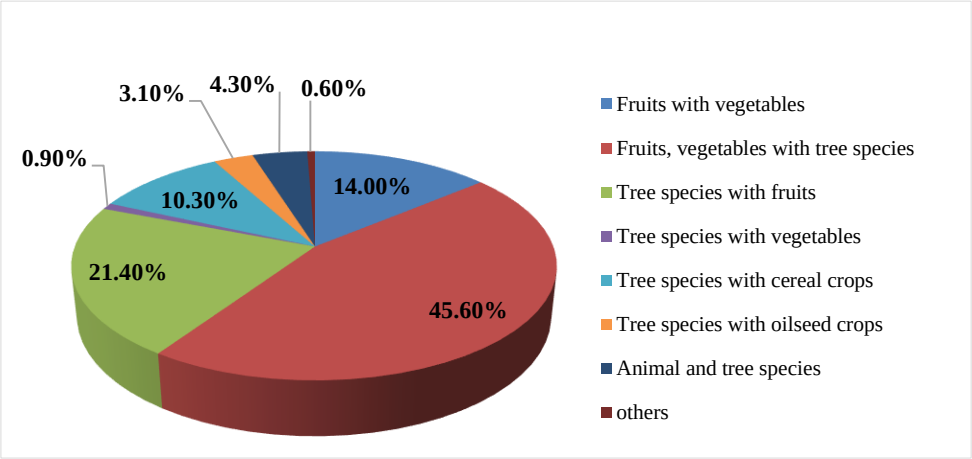

Figure 5. Distribution of the respondent according to profitable combination

Knowledge level of farmers on agroforestry system

To accept agroforestry practice as a business, farmers must have knowledge on its cultivation. Without the right level of knowledge, farmers will not be benefited by it. Farmers were given a series of statements to evaluate their degree of expertise, and their responses were recorded for further analysis. Based on figure 6, it was observed that a significant majority of farmers (45.4%) possessed a low level of knowledge regarding the agroforestry system. Additionally, 38.1% of the participants had a very low degree of knowledge in this area. Only a small proportion of farmers (15.9%) exhibited an average level of knowledge, and a mere (0.7%) of respondents had a high level of expertise on agroforestry in the hill area.

The higher percentage of farmers with low knowledge on agroforestry can be attributed to their educational background, as most of them had completed only primary and secondary levels of education. They may have chosen to adopt agroforestry practices as a means to earn income without seeking additional information or training. It is worth noting that agroforestry is often deeply rooted in traditional practices, which may explain why some farmers adopted this system without further exploration or research.

© 2024, e-ISSN 2682-7727 https://doi.org/10.17576/geo-2024-2004-09

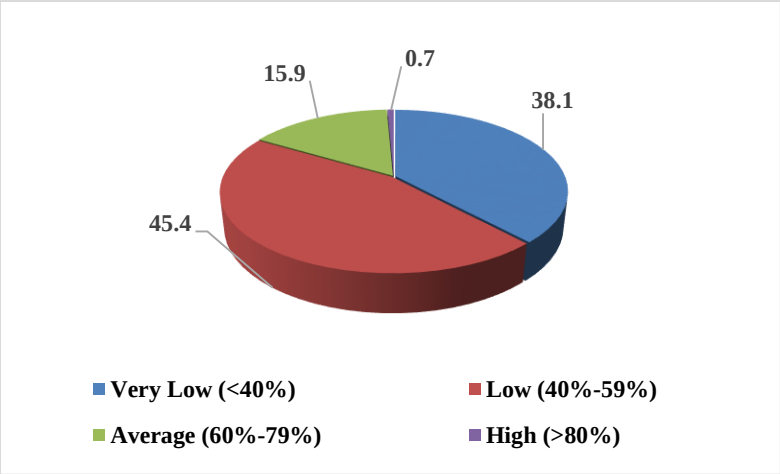

Figure 6. Distribution of the respondents according to their knowledge on agroforestry

In summary, the findings suggest that a large portion of farmers in the study area had limited knowledge about the agroforestry system. This can be attributed to their educational attainment and the prevalence of traditional agricultural practices. Enhancing awareness and providing targeted education and training programs could help improve farmers' knowledge and understanding of agroforestry practices, leading to more effective and sustainable implementation in the region.

Relationship between selected characteristics of the respondents and their knowledge of agroforestry practices

Correlation coefficients were computed to analyze the associations between respondents' awareness of hill agroforestry systems and specific sociodemographic characteristics, as presented in Table 2. This analysis uncovers substantial positive relationships among many characteristics and the respondents' comprehension of hill agroforestry practices.

Table 2. Relationship between the selected characteristics of the farmers and their knowledge on agroforestry system

Selected personal attributes	Co-efficient of correlation
Age	0.028
Numbers of family members	0.208**
Educational qualification	0.242**
Annual Income	0.126**
Land size	-0.071
Farming experience	-0.046
Cosmopolitan behavior	0.322**
Innovativeness	0.300**
Extension media contact	0.135*
Training on agriculture	0.268**

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows that family size, educational achievement, annual income, cosmopolitan behaviors, innovativeness, contact with extension media, and participation in agriculture training all had positive correlations with knowledge levels. Specifically, there was a positive correlation between larger family sizes, more educational credentials, and greater annual earnings with a more comprehensive comprehension of hill agroforestry practices. Furthermore, persons who possess more cosmopolitan views, exhibit higher degrees of innovativeness, engage in frequent interactions with extension services, and have undergone formal training in agriculture, also have improved understanding of these systems. The associations exhibited varying degrees of strength, although generally indicated a higher level of expertise with hill agroforestry practices linked to these characteristics. In contrast, variables such as land ownership, agricultural experience, and age of the respondents did not exhibit any significant relationships with their levels of knowledge regarding hill agroforestry. These findings indicate that specific sociodemographic traits can predict greater knowledge and potentially more successful implementation of hill agroforestry. However, factors such as farming tenure or land size do not directly influence comprehension of these methods.

Problems of agroforestry practices

Table 3 presents the distribution of respondents' opinions on the problems faced in agroforestry. The data reveals that the most significant issues, as reported by the farmers, were the lack of government support and the lack of capital. Jahan et al. (2022) found similar results in their study. These problems were ranked as the first and second most important issues, respectively. The study found that only 32.8% of farmers took loans from various organizations, indicating that most farmers were operating without financial assistance. The provision of low-interest loans by the government could potentially benefit farmers and support their cultivation activities.

Table 3. Distribution of the respondents according to their opinion regarding the problems of agroforestry

Sl. No.	Possible issues	Number of respondents			Total Score	Rank
		Mostly agree= 2	Somewhat agree= 1	Do not agree=0		
1.	Lack of planting material	78	103	69	259	10th
2.	Poor market accessibility	101	107	42	309	7th
3.	Lack of knowledge and technical skill	141	70	39	352	4th
4.	Lack of training facilities	159	52	39	370	3rd
5.	Lack of transport facilities	148	86	16	382	2nd
6.	Lack of government support	186	43	21	415	1st
7.	Longer gestation period of the tree crop	114	102	34	330	6th
8.	Shade problem	74	68	108	216	9th
9.	Labor intensive	84	120	46	288	8th
10.	Lack of advanced technologies	144	56	50	344	5th

Other major problems identified by the farmers included the lack of training facilities, transport facilities, lack of advanced technologies, and knowledge and technical skills. These issues were ranked third to seventh by the respondents. Uneven topography was also reported as a significant problem in agroforestry systems. Most of the land (87.1%) was identified as highland and not suitable for crop cultivation, while only 11.3% was considered flat land.

Farmers also highlighted the time-consuming nature of agroforestry practices and the long gestation period required for tree crops. These factors make agroforestry a long-term investment with potential environmental risks. Irrigation problems were mentioned due to the predominance of highland areas in the study region. Poor market accessibility, attributed to inadequate road networks and distance from markets, was another prominent issue faced by farmers during the marketing of agroforestry products.

Limited information and knowledge among farmers regarding the management of agroforestry crops and the availability of suitable land were additional challenges reported. Ulak et al, (2021) identified similar problems. Labor intensity and the lack of planting materials, particularly certified seedlings of forest and horticultural crops, were also identified as concerns. Farmers expressed fear that the shade caused by agroforestry trees could hinder the growth of agricultural crops, which are their primary focus. Competition for water and nutrients, low profitability, and difficulties in managing agroforestry were ranked as the least significant problems according to the respondents in the study area.

Overall, the findings emphasize the importance of government support and access to capital for farmers engaged in agroforestry. Additionally, addressing issues related to training, transportation, technology, information dissemination, and land suitability can contribute to the successful implementation of agroforestry practices.

Conclusion

The study explored the dynamics of agroforestry practices in the hilly regions of Rangamati, Bangladesh, within the context of challenges such as rapid population growth, deforestation, and environmental degradation. According to the findings, a majority of respondents have heard about agroforestry, yet there remains a notable lack of awareness regarding the practice. However, there is a notable increase in agroforestry adoption among farmers, particularly in cropland and fruit-based systems, reflecting a positive trend towards sustainable land-use practices. Selling fruits emerged as the predominant motivation for tree planting, particularly Mango and Banana trees being widely planted. The combination of fruit and vegetable production with tree species was the most preferred approach among farmers, highlighting a shift towards sustainable farming practices. Farmers' knowledge levels on agroforestry were found to be influenced by sociodemographic factors such as educational qualification, annual income, cosmopolitan behavior, innovativeness, extension media contact, and training on agriculture, emphasizing the need for targeted educational interventions and engagement with extension services. Challenges faced by farmers include limited government support and capital, as well as issues like inadequate training facilities, transport, technology, and knowledge. Addressing these challenges is crucial for successful agroforestry implementation. Despite challenges, agroforestry holds potential in mitigating deforestation and environmental degradation while providing diversified income sources for farmers. Government support, access to capital, and educational initiatives are crucial for fostering widespread adoption of agroforestry, contributing to economic well-being and environmental sustainability in Bangladesh's hilly regions.

References

Ahammad, R., & Stacey, N. (2016). In Deakin, L., Kshatriya, M., & Sunderland, T (Eds.), *Agrarian Change in Tropical Landscapes* (1ed., pp. 190-233). Center for International Forestry Research.

BBS. (2017). Statistical Pocket Book Bangladesh 2016, Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division (Sid), Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

BBS. (2022). Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh.

BBS. (2018). Yearbook of Agricultural Statistics. Dhaka: Ministry of Planning, Government of the people's Republic of Bangladesh.

FAO. (2010). Global Forest Resources Assessment 2010: Main report, FAO Forestry Paper 163, Food and Agriculture Organization of the United Nations, Rome (PDF) A review of the status and trends of forest cover in Bangladesh and Philippines.

Frey, G. E., Fassola, H. E., Pachas, A. N., Colcombet, L., Lacorte, S. M., Pérez, O., Renkow, M., Warren, S. T., & Cubbage, F. W. (2012). Perceptions of silvopasture systems among adopters in northeast Argentina. *Agricultural Systems*, *105*(1), 21-32.

Gain, P. (1998). Forest and forest people of Bangladesh. *Bangladesh: Land Forest and Forest people, Society for Environment and Humen Development (SEHD), Dhaka, Bangladeh*, 29-50.

Ghosh, M. K., Hasan, S. S., Fariha, R., Bari, M. O., & Parvin, M. A. (2021). Women Empowerment through Agriculture in Chapainawabganj, Bangladesh. *European Journal of Agriculture and Food Sciences, 3*(1), 153-160.

Ghosh, M. K., Jahan, M. L., Farjana, F., Hasan, M. Z., & Nahian, K. A. (2023). Possibilities and Challenges of Dragon Fruit in Chapainawabganj Region of Bangladesh from the Growers Perspective. *Turkish Journal of Agriculture-Food Science and Technology, 11*(4), 682-693.

Hanif, M. A., Bari, M. S., & Rahman, A. (2015). Potentiality of carbon sequestration by agroforestry species in Bangladesh. *Research on Crops, 16*(3), 562-567.

Hasan, S. S., & Sultana, S. (2011). Food and Economic Security through Homestead Vegetable Production by Women in Flood Affected Char Land. *The Agriculturists, 9*(1-2), 44-53.

Hasan, S. S., Turin, M. Z., Ghosh, M. K., & Khalil, M. I. (2017). Assessing agricultural extension professionals opinion towards sustainable agriculture in Bangladesh. *Asian Journal of Agricultural Extension, Economics and Sociology, 17*(1), 1-13.

Hossain, M. A. (2011). An overview on shifting cultivation with reference to Bangladesh. *Scientific Research and Essays*, *6*(31), 6509-6514.

Hossain, M. A., Jashimuddin, M., Nath, T. K., & O'Reilly, P. (2017). Spiny coriander (Eryngium foetidum L.) cultivation in the Chittagong Hill Tracts of Bangladesh: sustainable agricultural innovation by indigenous communities. *Indian Journal of Traditional Knowledge*, *16*(1), 59-67.

Jaganathan, D., Bahal, R., Burman, R. R., & Lenin, V. (2016). Knowledge level of farmers on organic farming in Tamil Nadu. *Indian Research Journal of Extension Education*, *12*(3), 70-73.

Jahan, H., Rahman, M. W., Islam, M. S., Rezwan-Al-Ramim, A., Tuhin, M. M. U. J., & Hossain, M. E. (2022). Adoption of agroforestry practices in Bangladesh as a climate change

mitigation option: Investment, drivers, and SWOT analysis perspectives. *Environmental Challenges*, *7*, 100509.

Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: an overview. *Agroforestry Systems*, *76*, 1-10.

Kerr, R. B., Hasegawa, T., Lasco, R., Bhatt, I., Deryng, D., Farrell, A., & Thornton, P. (2022). Chapter 5: Food, fibre, and other ecosystem products. IPCC WGII sixth assessment report, IPCC, Lausanne.

Meijer, S. S., Catacutan, D., Ajayi, O. C., Sileshi, G. W., & Nieuwenhuis, M. (2015). The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. *International Journal of Agricultural Sustainability*, *13*(1), 40-54.

Meybeck, A., Gitz, V., Wolf, J., & Wong, T. (2021). Addressing forestry and agroforestry in National Adaptation Plans: Supplementary guidelines. Food & Agriculture Org.

Nazu, S. B., Khan, M. A., Saha, S. M., Hossain, M. E., & Rashid, M. H. A. (2021). Adoption of improved wheat management practices: An empirical investigation on conservation and traditional technology in Bangladesh. *Journal of Agriculture and Food Research*, *4*, 100143.

Nkamleu, G. B., & Manyong, V. M. (2005). Factors affecting the adoption of agroforestry practices by farmers in Cameroon. *Small-scale Forest Economics, Management and Policy*, *4*, 135-148.

Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*, *46*(11), 1407-1424.

Quandt, A., Neufeldt, H., & McCabe, J. T. (2017). The role of agroforestry in building livelihood resilience to floods and drought in semiarid Kenya. *Ecology and Society*, *22*(3),10.

Rahman, S. A., Farhana, K. M., Imtiaj, A., Wachira, S. W., Rahman, M. A., & Saha, S. (2010). Sustainable forest management for poverty reduction through agroforestry options: lesson from the remote uplands of Eastern Bangladesh. *Libyan Agriculture Research Center Journal Internation*, *1*(3), 134-141.

Rahman, S. A., Imam, M. H., Snelder, D. J., & Sunderland, T. (2012). Agroforestry for livelihood security in Agrarian landscapes of the Padma floodplain in Bangladesh. *Small-scale Forestry*, *11*(4),529-538.

Rasul, G., & Thapa, G. B. (2006). Financial and economic suitability of agroforestry as an alternative to shifting cultivation: The case of the Chittagong Hill Tracts, Bangladesh. *Agricultural Systems*, *91*(1-2), 29-50.

Rosenstock, T. S., Wilkes, A., Jallo, C., Namoi, N., Bulusu, M., Suber, M., & Wollenberg, E. (2019). Making trees count: Measurement and reporting of agroforestry in UNFCCC national communications of non-Annex I countries. *Agriculture, Ecosystems & Environment*, *284*, 106569.

Saha, S., Sharmin, A., Biswas, R., & Ashaduzzaman, M. (2018). Farmers' perception and adoption of agroforestry practices in Faridpur district of Bangladesh. *International Journal of Environment, Agriculture and Biotechnology*, *3*(6), 1987-1994.

Sharmin, A., & Rabbi, S. A. (2016). Assessment of farmers' perception of agroforestry practices in Jhenaidah district of Bangladesh. *Journal of Agriculture and Ecology Research International 6*(4), 1-10.

SRDI. (2018). Annual Report 2017-18. Soil Resource Development Institute, Ministry of Agriculture, Government of the People's Republic of Bangladesh, Dhaka.

Ulak, S., Lama, B., Pradhan, D. K., & Bhattarai, S. (2021). Exploring agroforestry systems and practices in the Terai and hill regions of Nepal. *Banko Janakari*, *31*(2), 3-12.

van Noordwijk, M., Coe, R., Sinclair, F. L., Luedeling, E., Bayala, J., Muthuri, C. W., & Minang, P. A. (2021). Climate change adaptation in and through agroforestry: four decades of research initiated by Peter Huxley. *Mitigation and Adaptation Strategies for Global Change*, *26*(5), 1-33.

Zakaria, A. F. M., & Majumder, N. M. (2019). Are khasis of Bangladesh eco-friendly agro manager? Reflections on hill farming practices and forest conservation. *Journal of Science, Technology and Environment Informatics*, *8*(1), 574-582.