This article can be found in: Torquebiau E (ed.). 2024. Agroforestry at work. *Tropical Forest Issues* 62. Tropenbos International, Ede, the Netherlands (pp. 160–165).

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Agroforestry on depleted Sal forestland in Bangladesh. Photo: Kazi Kamrul Islam

Agroforestry for income and livelihood development of ethnic minorities in Bangladesh

Kazi Kamrul Islam

"The productivity of agroforestry on deforested land has greatly enhanced the livelihoods of ethnic minorities."

Introduction

Agroforestry on depleted forestland has made enormous changes compared to traditional forest management approaches in developing countries. The various tree, crop and animal products provided by agroforestry systems support the basic needs and uplift the livelihoods of millions of smallholders throughout the world. Bangladesh is a developing country with only 17% forest, which faces tremendous pressure from people who depend on forests for their daily living. Of the country's three major forest types, the moist deciduous Sal (*Shorea robusta*) forest (0.12 million ha), is the most deforested and degraded, with population pressure seen as the main cause of this. Of the original area of Sal forest, only 36% was left in 1985, falling to 10% by 2008 (Alam et al. 2008; Islam and Sato 2012).

Accordingly, people-oriented forest management approaches such as agroforestry have been practised in; e.g., the major Sal forest near the town of Madhupur since 1989 (Islam et al. 2022; Islam and Hyakumura 2021).

This article explains how agroforestry has affected income generation and livelihood enhancement for ethnic farmers in the Madhupur Sal forest of Bangladesh. In this area, more than 50,000 people — including 20,000 ethnic minorities (Garo and a few Koch) — practise agroforestry and their livelihoods depend on it. A livelihood comprises natural, physical, human, financial and social capital, as well activities and physical access, which together determine the level of living gained by the individual or household (DFID 2000). These types of capital are the building blocks of farmers' livelihoods and all of them are needed to achieve livelihood outcomes (DFID 2000). Previously, ethnic farmers were fully dependent on Sal forests to sustain their daily living; now, agroforestry could play a significant role in improving the communities' livelihoods.

Sal forests and agroforestry

The condition of the Madhupur Sal forest varies, from open, heavily used and degraded scrub to relatively dense Sal coppice regrowth and scattered trees (Islam et al. 2013; NSP 2008). See Figure 1. It is noteworthy that significant plant variety still exists, despite the fact that all places have had some degree of use. Huge wildlife species (e.g., tiger, leopard, elephant, sloth bear and spotted deer) have been eradicated from the forest (NSP 2008). It has been estimated that there are 176 species of woody plants (73 of which are trees) and 140 species of birds, 19 species of mammals, 19 species of reptiles, and 4 species of amphibians in the forest. The dominant tree species (more than 80%) is the commercially profitable Sal. Tangail and Mymensingh Forest Divisions have administrative jurisdiction over the forest.

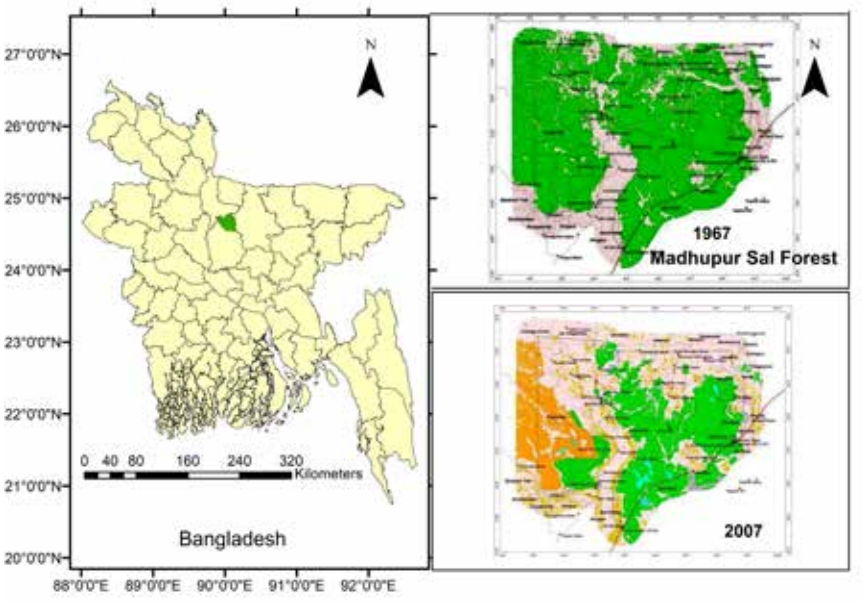

Figure 1. Location of Madhupur Sal forest of Bangladesh and the extent of forest in 1967 and 2007
Orange: rubber plantations; pink: agricultural practices; green: forest

Ethnic minorities have a long history related to the forest. Sal forest-dependent Garo (who comprise most of the communities) and a few Koch ethnic communities established themselves in the Madhupur Sal forest more than 200 years ago (Islam and Sato 2013). Due to the severe deforestation of Sal forests in the 1970s, the Bangladesh Forest Department started to carry out people-oriented forest management programmes in 1989. Agroforestry was part of this initiative. Each farmer gets 1 ha of deforested land to implement agroforestry and shares 50% of the income of the planted trees with the department after a 10-year cycle. Local farmers can cultivate seasonal crops in association with the planted trees, and the entire crop is the sole property of the farmer. Besides these government-run programmes, local people are also practising agroforestry on their own land, producing multiple crops in association with fast-growing trees such as *Acacia* spp. A previous study (Islam et al. 2022) found that more than 90% of local farmers were mainly using acacia (*Acacia auriculiformis*) trees with a few *minjiri* (*Cassia siamea*), *gamar* (*Gmelina arborea*), neem (*Melia azedarach*), jackfruit (*Artocarpus heterophyllus*) and eucalyptus (*Eucalyptus camaldulensis*) trees on their agroforestry lands. Except for jackfruit these

Acacia-turmeric (left) and Acacia-pineapple (right) agroforestry crops at Madhupur, Bangladesh. Photo. Kazi Kamrul Islam

are fast-growing tree species that are a potential source of firewood and income generation for local farmers. Various types of crops, in particular the shade-loving pineapple, ginger, aroids and turmeric, are the dominant crops. Pineapple is the most common crop.

Research approach

The local Forest Department made farmers' data available to the project before the study team randomly selected 90 ethnic farmers from five villages across the entire Madhupur Sal forest area (each farmer being a member of a single household). Both men and women are farmers, and all of them live in poverty. Both quantitative and qualitative data were gathered for the study, and the study team developed a semi-structured questionnaire for the farmers' interviews. Focus group discussions, opinions from the Forest Department staff, and practical observation methods were used to gather qualitative data. The questionnaire was created to gather comprehensive economic data regarding the agroforestry programme and the participants' socioeconomic information, and a preliminary survey was carried out to test it.

The harvesting time of the agroforestry crops varies among species; for example, pineapple provides a first harvest at 18 months, after the transplanting of suckers and continues to generate income for four years. This means that the crop outputs differ according to which type of agroforestry is practised. The study determined the crop production costs and yield/ha on a yearly basis, calculating the prevailing average unit market price in the local currency (Bangladeshi taka, or BDT), later converted into USD (United States dollars); BDT 85 = USD 1 at time of writing. In the case of mixed cropping, the team collected the data and carried out the conversion per hectare separately for each crop. Trees were harvested after ten years and the total output (firewood, timber, fodder) from them was determined and then calculated on a yearly basis. The study also determined the benefit-cost ratio (BCR) of each crop combination. With the support of two enumerators, the entire data collection process was completed from 2020 to 2022.

Types of agroforestry practices

The research team found five types of profitable agroforestry practices in Madhupur.

Acacia-pineapple-papaya

Acacia (*Acacia auriculiformis*) is a fast-growing species, planted by farmers along the boundaries of fields or inside the land in a scattered manner. The spacing of the acacia trees depends on the individual farmer's choice, but on average there were ±400 trees per hectare. Farmers transplanted pineapple suckers (30×40-cm spacing) between tree lines and included papaya sparingly in the pineapple lines. Around 22,000

pineapples and 600 papaya plants per hectare are planted. The acacia-pineapple-papaya agroforestry practice can produce for up to ten years. The pineapples produce for up to four years; after ten years, the acacia wood is harvested and sold in the market. Usually, pineapples start yielding at 18 months and the papaya trees provide a good yield for two to three years. Farmers earn their highest economic income in the second year of this agroforestry practice.

Acacia-pineapple-ginger

The acacia trees are planted in a scattered fashion, and the pineapple and ginger crops are planted in alternate rows, with one row of ginger between two rows of pineapple. Around 22,000 pineapples and around 600 kg (17 mounds) of ginger rhizomes are planted per ha. The soil type and climate of the area is suitable for growing shade-loving agroforestry crops such as ginger, which does well under these conditions. This agroforestry practice usually continues for ten years, after which the acacia trees are cut down and a new cycle starts.

Acacia-pineapple-turmeric

This practice follows the same planting techniques as for acacia-pineapple-ginger, with turmeric replacing ginger. The amount of turmeric seeds planted per ha is about 165 kg. Turmeric is a seasonal crop and is harvested before the pineapples ripen, allowing farmers to get an early income.

Jackfruit-pineapple-papaya

This is a popular and common practice in the Madhupur Sal forest area. Jackfruit is a traditional and evergreen fruit tree species that has been grown in this region for a long time. The jackfruit trees are planted along the boundaries of the cropland as well as inside it in a scattered manner, and various crops are grown in association with them. Ethnic farmers cultivate pineapple and papaya in association with jackfruit trees right at the beginning of their agroforestry practice. Farmers plant around 100 to 150 jackfruit trees, around 18,000 pineapple and 200 papaya plants per ha.

Acacia-pineapple-aroid

A range of varieties of aroids (*Colocasia esculenta*) were observed in the study area. Aroid tubers are very nutritious and shade-tolerant and require few inputs for production. They are planted between pineapple rows and around 450 kg of "seeds" (i.e., small pieces of the tuber) per ha are required, with 20,000 pineapple suckers and 400 acacia trees per hectare. Intercultural operations are minimum for aroid crops, while other operations are the same as in the other agroforestry practices.

Economic outputs of agroforestry

Economic analysis revealed that all five practices generated significant income for farmers. The acacia-pineapple-ginger association produced the highest output of USD 5,088 ha/year, followed by acacia-

Ethnic farmers participate in a range of agroforestry practices; left: turmeric; right: pineapple. Photo. Kazi Kamrul Islam

pineapple-aroid (USD 4,149), jackfruit-pineapple-papaya (USD 3,235), acacia-pineapple-papaya (USD 3,092) and acacia-pineapple-turmeric (USD 3,235). See Table 1. Tree (timber) income did not vary significantly across the five practices, as the total gross income of the agroforestry practices depends mainly on income from crops. The labour cost in all models was the highest cost, although farmers mentioned that labour requirements decreased with the age of the plantation. The total production cost was highest for the jackfruit-pineapple-papaya association (USD 2790/ha) and lowest for the acacia-pineapple-aroid system (USD 2,044/ha).

To measure profitability, all costs during the ten-year rotation period and the income from sales of both trees and crops were assessed. The net profit of the five different agroforestry systems showed that the acacia-pineapple-aroid model is the most profitable, as the market price of aroids did not vary, and costs of production were low. This practice has the highest benefit-cost ratio (BCR 3.03). Despite this, however, farmers in the Madhupur Sal forest area widely practise the pineapple-based production model because pineapple provides returns as soon as four years after initial planting, and there is a well developed pineapple marketing system in the area.

Table 1. Cost of production, total income and net income (USD) of agroforestry practices (ha/year)

	Agroforestry practice				
	Acacia-pineapple-papaya	**Acacia-pineapple-ginger**	**Acacia-pineapple-turmeric**	**Jackfruit-pineapple-papaya**	**Acacia-pineapple-aroid**
Production costs					
Tree seedlings	232	207	212	251	216
Land preparation	181	191	198	227	128
Planting material	335	369	349	325	314
Labour	642	802	733	757	515
Fertilizer and manure	311	326	251	205	158
Pesticide	77	92	232	263	76
Weeding/irrigation	112	146	132	158	158
Harvesting	299	393	314	311	288
Sticks to support plants	99	67	100	114	69
Transport	12	9	8	10	11
Miscellaneous	103	169	146	169	111
Gross income					
Timber income*	529	482	506	565	518
Thinning tree income	94	82	59	71	106
Firewood income	34	29	26	29	24
Fodder income	8	11	6	5	9
Crop income	4,829	7,253	4,534	5,355	5,537
Total gross income	5,495	7,858	5,131	6,025	6,193
Total production cost	2,404	2,770	2,675	2,790	2,044
Net income	3,092	5,088	2,455	3,235	4,149
Benefit-cost ratio (BCR)	2.29	2.84	1.92	2.16	3.03

*The income from timber shown here represents the 50% share received by the farmer; this was calculated on a yearly basis.

Livelihood development

Most agroforestry farmers in the Madhupur area are poor people from ethnic minorities. After being involved in the agroforestry programme, their livelihood assets improved. The literacy rate of farmers and their children gradually increased. Participating farmers got involved in various organizations to get loans and technical assistance to manage their agroforestry fields, thanks to the high number of NGOs and GOs present in the area. Participants' awareness of health care facilities improved, and a Christian missionary provided basic health care.

Local road infrastructure gradually improved; mud roads have been replaced by bitumen roads. Forest Department staff mentioned that people-oriented programmes and tourism have had an impact on improving road infrastructure. Farmers had received a good amount of money by selling timber at the end of the ten-year period, which they mainly used to improve their house structures with tin walls and roofs. Ethnic farmers were also able to buy chickens, pigs and cattle with the money they received from agroforestry. The available labour provided by the participants' family had decreased, however, due to the awareness of education and migration to the capital city for jobs in the garment industry.

Farmers received income from seasonal crops throughout the year, and this increased their food self-sufficiency rate for 11 months of the year. With the income from agroforestry, farmers can also manage their family health care and visit the local hospital/clinic for treatments. The most positive aspect of agroforestry was to increase the number of trees, both in farmers' households and in agroforestry fields.

Conclusions

Agroforestry is an effective approach to generating household income for poor ethnic farmers in the Madhupur Sal forest area. As a production system based on tree crops, aroid-pineapple-based agroforestry has numerous benefits that contribute to generating household income generation and improving the livelihoods of rural farmers. The results of this study showed that agroforestry based on aroid-pineapple increases farmers' total household income by maximizing the benefit-cost ratio of the farm. The study concluded that the impacts of agroforestry practices had strongly improved the financial, physical and natural assets of ethnic farmers. However, the development of social and human capital was still not satisfactory. The social relationships and networks of the farmers had not fully developed, or they faced constraints. More emphasis needs to be placed on the development of high-yield agroforestry practices, together with farmer training programmes, to further improve farmers' livelihoods and overall farm productivity.

Acknowledgements

Research was conducted with financial support from a Ministry of Education, Bangladesh-funded project (ID No. LS20191222).

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