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Participatory agroforestry for disadvantaged community development: Evidence from Madhupur Sal forests, Bangladesh

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Abstract: In the last few decades, participatory forest management approaches like participatory agroforestry in the depleted forestland has gained an enormous shift from traditional forest management to more people-oriented approaches in Bangladesh. The new program has involved disadvantaged farmers in order to improve their livelihood throughout the Sal forest cover ranges, however, the program's role in local community development has not been assessed thoroughly. Therefore, the study was undertaken to identify the potential participatory agroforestry models and their income-generating capacity towards community development in the Madhuur Sal forests of Bangladesh. Using different qualitative and quantitative data collection techniques, the study identified mainly four types of agroforestry models which were comprised of pineapple, ginger, turmeric and aroid crops in association with Acacia trees. The economic analysis showed that the Acacia-Ginger agroforestry model gave the highest gross income, however, in terms of the benefit-cost ratio, the aroid-based agroforestry model was the most profitable production system in the Madhupur Sal forests area. Moreover, these agroforestry models have simultaneously improved poor participants' social, physical, human and ecological assets. So, the study argues that participatory agroforestry models not only provided economic returns but also augment the livelihood of the poor participants and thus, developed their community as a whole. At the same time, the agroforestry models have faced some major constraints led by the government authorities and local leaders. So, there is an immediate need to resolve the major problems of the economically viable models, by which the local participants can effectively practice tree-crop production systems and improve their livelihood as well as the communities in a sustainable way.
Key words: Agroforestry, Sal forest, Income, Benefit-Cost, Livelihood, Bangladesh.

Introduction

Decentralization in forest resources management has started as a strategy to responses institutional failure, thus, participatory forest management has become major policy trends in many of the world's developing countries including Bangladesh (Ribot, 2002; Gilmour, 2003; Islam *et al*., 2015, 2013, 2011). The participatory forestry program has strongly supported obtaining social, economic and ecological sustainability (Bowler *et al*., 2012; Ostrom, 2009; Islam and Hyakumura, 2018, 2019).

The forests of Bangladesh are comprised of evergreen Hill, moist deciduous Sal and Mangrove forests which show great richness and diversity of species. The moist deciduous Sal forests are one of the most ecologically and economically import forest type of Bangladesh surrounded by a high density of poor communities. These Sal forests are also considered the most threatened ecosystems (Gain, 2002; Islam and Sato, 2012a, 2012b, 2013); thus, the Forest Department (FD) of Bangladesh has started different types of participatory forestry approaches including local communities in forest resources management. The FD gives priorities to the local people living in and around the Sal forests area to include the programs with a hope that it would simultaneously improve the forest condition and livelihood of the disadvantaged communities. Participatory agroforestry in the Madhupur Sal forest area is one of the important participatory programs which is accepted by the local communities and considered as an economically viable program in managing the depleted Sal forestland of Bangladesh. Agroforestry is a sustainable land-use system by growing different species of woody perennials in association with agricultural crops, which can improve the degraded areas successfully (Nair, 1990; Islam *et al*., 2015). Being a sustainable land-use system, agroforestry has been specially considered as an effective and low-cost method as it can help to minimize the process of soil degradation and also provide several outputs in a given piece of land.

In Madhupur Sal forests, more than three thousand households are practicing tree-crop based participatory agroforestry models prescribed by the FD since 1989. Local farmers are cultivating varieties of crops in association with multipurpose trees in the government-owned degraded Sal forests area. Therefore, the participatory agroforestry program in the Sal forests area has created great diversity in the social relationships and interests among the different stakeholders. Commonly, participatory agroforestry has characteristics by many stakeholders due to the economic, ecological, social functions and values that Sal forests deliver. On the contrary, this noble approach is still treated as a donor-funded and government-controlled program in Bangladesh (Islam *et al*., 2012, 2013; Muhammed *et al*., 2008), and there is a lack of information to what extent the program has improved the socioeconomic condition of the local poor communities. Therefore, the objectives of the study were to identify the potential participatory agroforestry models and their economic returns towards community development functions in the Madhupur Sal forests of Bangladesh.

Materials and Methods

Study area: The study was conducted in the Madhupur (45,565.2 acres; major Sal forests tract) Sal forests area which is administrative consists of Tangail and a small portion (593 acres) of Mymensingh districts of Bangladesh (Figure 1) (Islam et al. 2012; Islam and Hyakumura 2018, 2019). The participatory agroforestry program was implanted in the four Ranges of Tangail district, and the study selected three Ranges namely- Dhokola, Auronkolaa, and Madhupur Ranges for data collection.

Description of the Participatory Agroforestry Program: Under the participatory forestry concept, the FD was implemented in different types of models in which the Woodlot and Agroforestry were the successful models

in the Madhupur Sal forest area. Both models were designed to grow the fast-growing tree species in 1ha of bare forestland within a rotation of a 10-year cycle, and each participant can continue up to 30 years if he/she maintained program criteria properly. The FD and participant shared the benefit of the tree outputs at a ratio of 45%:45% and the remaining 10% benefit reserved for the Future Tree Farming Fund (TFF). However, the participant can grow crops in association with trees at any time of the program cycle, and participants would not need to share the crop benefit. The crop cultivation area was higher in the agroforestry model compared to the woodlot, however, both models were considered as agroforestry as they consist of trees and crops produced in the same piece of land (Nair, 1990).

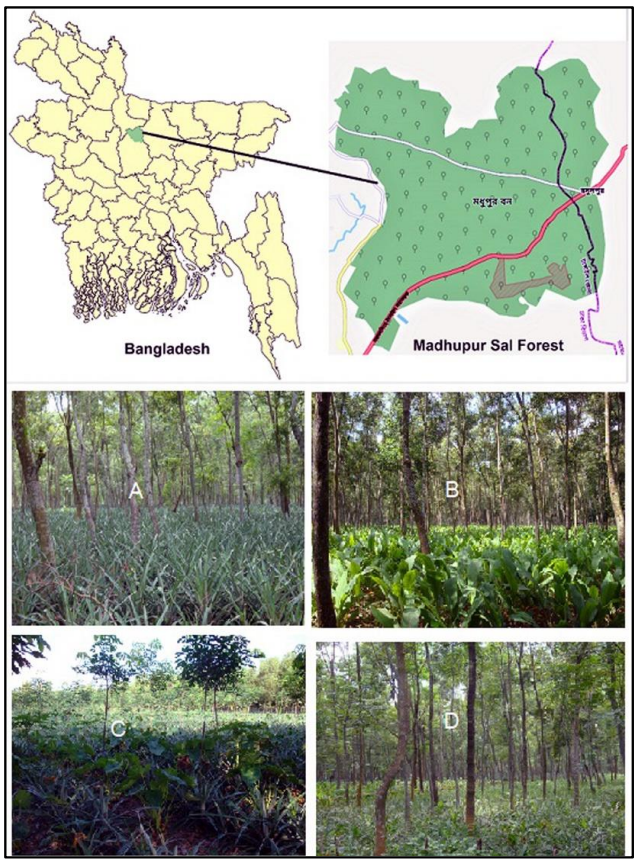

Figure 1. Study area map with four major agroforestry models (A= Acacia-Pineapple, B=Acacia-Turmeric, C=Acacia-Aroid, and D=Acacia-Ginger) in the Madhupur Garh.

The study observed that more than 97% of farmers were using only Acacia (*Acacia auriculiformis*) tree and only a few farmers have been growing Minjiri (*Cassia siamea*), Gamar (*Gmelina arborea*), Neem (*Melia azedarach*), and Eucalyptus (Eucalyptus camaldulensis) in association with Acacia tree in their agroforestry models. The participants have cultivated shade-loving crops like- pineapple, ginger, turmeric, and aroid at a different time of the program cycle. Therefore, the study categorized four types of common agroforestry models namely- Acacia-Pineapple, Acacia-Turmeric, Acacia-Ginger, and Acacia-Aroid in the Madhupur area. However, the combination of two or three crops was often observed in the same agroforestry model.

Sampling and Data Collection: The participatory/social forestry program guidelines mentioned that the programs were designed for the disadvantaged and landless people of the local communities, the criteria were not executed properly in the Madhupur area but and the study only selected poor people for data collection. The study first collected participants' secondary data from the local FD and randomly selected 90 farmers (called participant, each participant belongs to each household) from the three Ranges. The participants were belonging to both poor men and women living around the 11 villages of Madhupur Sal forest area. The study collected both qualitative and quantitative data, and for quantitative data, we used a semi-structured questionnaire interview technique. Qualitative data were collected through in-depth interviews, focus group discussions, forest department staff opinion and observation techniques. The study also used secondary data from different reliable sources. A preliminary survey was conducted to test the questionnaire, and the questions were designed to collect details economic data of the participatory agroforestry models and the participants' socioeconomic information. For the economic aspect, the study collected data from 20 farmers as these farmers were able to provide the 10-year complete data (5 farmers in each model); and the entire data collection was carried out from different months of 2015 to 2018 with the help of two enumerators.

Analytical framework: The duration of the agroforestry crops varies from each other, for example, pineapple starts to harvest at 18 months and continue to return up to 5 years. So, the calculation of crop output would differ from each other model, and the study calculated the crop production costs and yield/ha in year basis with their prevailing average unit market price. In the case of mixed crops, the study considered the sole crop yield and converted into a hectare. The tree was harvested after 10-year, so, the total output (fuelwood, fodder and thinning) of trees was determined and calculated on yearly basis. The study also calculated the Benefit Cost Ratio (BCR) of each model, which indicates the rate of return per unit cost, was calculated using the following formula, $\mathrm{BCR} = \frac{\sum_{i=0}^{n} B_t(1+i)t}{\sum_{i=0}^{n} C_t(1+i)t}$, here, B_t= gross benefit in i^{th} year, C_t= total cost in i^{th} year, t= number of year and i= interest (discount) rate (assuming 11% interest rate). Finally, the collected data were tabulated and analyzed using the computer Microsoft Excel program.

Results and Discussion

Economic Return of the Participatory Agroforestry: The participatory agroforestry models were executed to improve the Sal forest cover and livelihood of the local community. The economic analysis showed that all four models could generate income for the participants, of them, the Acacia-Ginger based agroforestry model produced the highest output of 665,100 Taka followed by Acacia-Aroid (482,700 TK), Acacia-Pineapple (442,900 TK) and Acacia-Turmeric (413,507 TK) models respectively (Table 1). The outputs of tree income did not vary significantly as the total gross income of the

agroforestry models depends on mainly crops income (Table 1). The cost of production of crops was higher at the beginning of the program cycle or year 1 and two. Accordingly, the cost of seedlings or planting materials were much higher in the first year, however, the labor cost of all models was higher than other costs. The participants mentioned that the availability of the day labor was decreasing and their daily wage was increasing day by day in the Madhupur area. The cost occurred in the cultivation of 1 ha Acacia-Ginger model was the highest (239244 TK) and the Acacia-Aroid model was the lowest (158300 TK) (Table 1). To measure profitability, all cost occurred during the rotation period of 10-year and income from the sells of both tree and crops were assessed accordingly.

Table 1. Cost of production, total income and net income of agroforestry programs in hectare per year.

Items	**Agroforestry Models**			
	Acacia-Pineapple (TK.)	Acacia-Ginger (TK)	Acacia-Turmeric (TK.)	Acacia-Aroid (TK.)
Tree seedlings costs	18500	16800	17000	17500
Land preparation costs	16425	17796	15818	9856
Crop seedlings/ /rhizomes/ sucker buying costs	29200	33367	29659	26752
Labor costs	56575	71182	59318	40832
Fertilizers costs	20075	20020	11864	7040
Manure costs	7300	8898	9886	5632
Insecticides & pesticides costs	5475	8898	21750	5632
Weeding and Irrigation costs	9125	11122	9886	11264
Harvesting costs	27375	35591	27682	25344
Other management costs	10950	15571	11864	8448
Timber income*	43000	38000	47000	40000
Thinning tree income	7000	6000	8000	5000
Firewood income	2800	2400	2200	2000
Fodder income	600	800	400	500
Crop income	389500	617900	355907	435200
Total Gross Income	442900	665100	413507	482700
Total Production Cost	201000	239244	214726	158300
Net Income	241900	425856	198781	324400
BCR	**2.20**	**2.78**	**1.93**	**3.05**

*Total income of trees was calculated in the year basis

The net profit of the different models showed that Acacia-Aroid is the most profitable agroforestry model in the study area as the market price of aroid did not varied, and the cost of production of this model was minimum. Moreover, the Benefit Cost Ratio is a common indicator of economic analysis as it takes into account both costs and returns of both components over the 10-year cycle of each agroforestry model. The results showed that the Acacia-Aroid was the most cost-effective model having the highest BCR (3.05) in the study area. Despite the highest BCR value of the Acacia-Aroid model, the farmers of the Madhupur area widely practiced the pineapple-based production model. It was due to fact that the pineapple provides return up to 5 to 6 years after initial plantation of pineapple crops, and a good pineapple marketing system has been built up in the Madhupur area. Similarly, in the previous study Islam *et al*. (2011), Kibria and Saha (2011) reported that pineapple and aroid-based agroforestry practices were highly benefited and income-generating for the local farmers of the Madhupur area. The participants also mentioned that the price of crops like turmeric varies in the main season and often, farmers were not getting the proper price of their products due to market monopoly and control by a few powerful businessmen.

Livelihood and Community Development: Participatory agroforestry farmers of the Madhupur area were the poor people of the community who do not have separate production and consumption option (Muhammed *et al*., 2008; Islam *et al*., 2012). After involvement in the program, they were able to build their livelihood assets which in turn develop their community as well, and this study examines some major parameters of their community development.

Through participatory forestry programs, a number of training sessions, workshops and field visits were conducted by the FD and NGOs. These training sessions were conducted at the local level to raise awareness and capacity building of the participants. The data from the local participants and FD office showed that the training sessions offered by the local FD played a valuable role in building the farmers' capacity and awareness at the community level. For example, the literacy rate of the participants and their children was gradually increased (Table 2). The participants have involved in different organizations to get loans and technical assistance to manage the agroforestry models, and the study observed that the number of NGOs and GOs was more than 21 in the Madhupur Sal forests area. Participants' awareness of health care facilities has been improved and the Christian Missionary extending their hands to provide basic healthcare facilities to the poor people in the Madhupur Sal forests area.

On the contrary, local road infrastructure was gradually improved and mud-roads have been replaced by the bitumen sealed roads (Table 2), the FD staff mentioned that participatory management programs and tourism have an impact to improve the road infrastructure of Madhupur Sal forests. The participants had received a good amount

of tree selling money at the end of the 10-year program cycle, in which they improved their house structure with tin-walled and tin-roof type, Islam and Sato (2012a) reported similar findings in their study at the Madhupur area. Participants were also able to buy small and big livestock with the money they received from agroforestry programs. Besides, few participants mentioned that they bought television and radio with the profit from the agroforestry models. The available labor of the participants' family had decreased and it was due to the awareness of education and migration to the capital city for garments job, mentioned by the respondents and experts.

Table 2. State of major characteristics of the participants and to the community.

Parameters	Participants and Trend
Adult Literacy rate	43.5%, Improving slowly
Children literacy rate	82%, Sharply improving
Social organizations	>13, Increasing
NGOs and GOs	>21, Increasing
Loan/Credit	Increase microcredit/easy loan
Training received	78%, Increasing
Household structure	Tin-wall and Roof, shift from mud-wall and sun-grass roof
Road infrastructure	Brick and bitumen seal
Livestock small (e.g. chicken)	4.5, Increasing
Livestock big (e.g., cow, goat)	2.1, Slightly improving
Available of labor	1.6, slightly decreasing
Alternative market facilities	Only one, Not changing
Food sufficiency during the year	10.5 months, Increasing
Annual expenditure	97.5%, Slightly improving
Local Clinic and Hospital	3, Improving
Tree stock in household premises	18.5, Improving
Tree stock in AF programs	480, Not changing
Dependency on Sal forest	Medium to low, previously high
Alternative livelihood options	Increasing

Marketing channel and monopoly is a major problem faced by the Madhupur farmers and for this, the local farmers did not get the proper price of their product. The study found only one big market, namely Jalsatro Bazar for marketing local agricultural products, and at least three to four levels of intermediatory were actively involved in the agroforestry product marketing channel. Many researchers had already mentioned the market monopoly and long intermediaries' channels in the Madhupur area (Islam and Sato, 2012a; Muhammed *et al*., 2008; Islam *et al*., 2015). Participants would receive seasonal crops income throughout the year and it increased their food sufficient rate to 10.5 months per year (Table 2). With the income of the agroforestry model, the participants can also able to manage their family healthcare systems and visited the local hospital/clinic for the treatments. The most positive side of the participatory agroforestry was to increase the tree coverage in both participants' households and agroforestry plots. Initially, every participant received 200 tree seedlings for free of cost to plant in their household premises, and FD tries to create participants' awareness on increasing tree cover of Madhupur Sal forests through training and workshops. It would simultaneously increase the tree coverage and decrease the participants' dependency on Sal forests for firewood. Literature found that the local people's dependency on Sal forests were very high in the Madhupur area (Islam and Sato, 2012; Islam *et al*., 2011; Muhammed *et al*., 2008).

The FD initiated a big project from 2009 to 2015 which main aim was to the rehabilitation of local poor people through different livelihood options and participatory forestry participants gave priority in this regard. That means the livelihood option has increased for the local participants and the rehabilitation project was treated as one of the successful programs in improving Sal forest condition and community development as well (Islam and Sato, 2013, Islam *et al*. (2013). Although the study has been observed that participatory agroforestry had a positive impact on poor participants, it is also found that the impact was constraints and hindered by the controlling attitude of the government foresters. The participants anonymously mentioned that the participatory agroforestry program was controlled and all of its decision made by the local forest department, there was no participation of poor people in decision making and management plan of the agroforestry models in the Madhupur area; Gain (2002) and Islam *et al*. (2013) also mentioned similar types of findings in their studies at Madhupur Sal forests area. The consequence had been lowering the participatory forestry overall goal and widespread dissatisfaction by the poor participants.

Social Relationship of the Participants: Social relationships and networks are valuable and critical resources for poor people, especially during times of family crisis and socioeconomic changes. The study found that the participatory agroforestry created a new social platform and the participants were organized as an independent social group. In a measurement scale of a 5-point Likert scale, (such as +2 strongly positive, +1 positive, 0 neutral, -1 negative and -2 strongly negative) the study revealed that the participants possessed a strongly positive relationship among themselves (Figure 2). However, the participants showed a negative relationship with local FD and leaders, and the study found that forestland user rights and participatory forestry program controlling power by the FD have created distance with local participants, and local leaders support the FD in this regard. Besides these two stakeholders, the

local participants possessed a good relationship with other stakeholders of the community. Although social relationship and networks are attributes of an individual in a social context (Sobel, 2002), the establishment of social assets depends on the institution, attitudes and values that govern interactions among participants and contribute to economic and social development (World Bank, 2002); and the overall social assets of the participants in the study area has been improved.

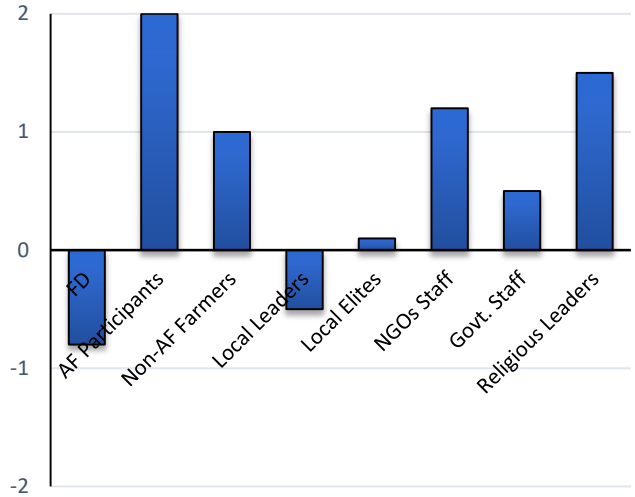

Figure 2. Social relationship of the participants in the community.

Table 3. Major constraints of the participatory agroforestry faced by the participants.

SL No	Problems	% (n=90)
1	Bureaucracy	89
2	Illegal money demand by FD officials and local leaders	76
3	Lack of alternative market facilities	47
4	Unexpected diseases and pests attack	44
5	Middleman exploitation in product marketing	42
6	Lack of healthy seedlings/planting materials	40
7	Unstable price of pesticides and fertilizes	39
8	Lack of pesticide and fertilizers	38
9	No credit or easy loan facilities by the GOs or NGOs	36

Major Constraint of the Program: The study also tried to figure out the main obstacle that discouraged participants and affected the income generation of the participatory agroforestry models. Most of the participants (89%) reported that they had to face bureaucracy problems at the time of getting their agroforestry land in bilateral agreements with local FD (Table 3). Participants had to wait a long time and often faced illegal money demand by the FD officials to obtain the land or selected as a participant in this program. Conversely, the forest officials mentioned that they tried their best to process the program quickly, but due to some official formalities and high officials' permission it took time, and they refuted claims of illegal money demands. One of the important problems mentioned by the participants was the marketing monopoly and intermediaries, the government would need to improve the market monitoring systems to improve the condition (Islam *et al*., 2012). Besides these problems, the local participants have faced a lack of healthy seed/seedlings, pesticides, fertilizers and easy loans or low credit loan facilities in the Madhupur Sal forests area. The study revealed that these major problems have to hinder the profitability of the agroforestry models and thus, affecting the participants' community development process.

Conclusion

Participatory agroforestry is an effective approach for generating income for the disadvantaged people of the Madhupur Sal forests area, and the results showed that all agroforestry models have a high potentiality to augment participants' household income. Cultivation of profitable crops like aroid, ginger and pineapple would maximize the net profit of the poor participants. Overall, the participatory forestry approach that was designed by the FD has great potential to improve the socioeconomic condition of the participating people which in turn develops the participants' disadvantaged community as well. However, this community development process would be more speed-up with the active cooperation of the local forest department and local leaders, and their role would be facilitators in this regard. The social relationship dynamics showed that the participants had possessed a negative relationship with the local forest department, and it is considered one of the important constraints to achieve the overall goal of the program. In conclusion, it can be argued that the participatory agroforestry approach is no doughtily a good initiative to enhance the disadvantaged community development process, and the local forest department and other stakeholders would need to work together with poor participants. Managing the participatory approach in such a coordinated and cooperative manner will ensure maximum economic return, protect Sal forests for further depletion, improve participants' livelihood, and be an ideal example for the disadvantaged community development in Bangladesh.

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