

Socio-Economic Impact of Cropland Agroforestry: Evidence from Jessore District of Bangladesh

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Abstract: *This study attempts to explore the socio-economic impact of cropland agroforestry in Bangladesh. We surveyed 84 farmers of two sub-districts named Manirampur and Bagherpara under Jessore district in the south-west region of Bangladesh through using a questionnaire during the period of June to July 2013. It follows a multistage random sampling procedure for selecting respondents. The main objective of the study is to assess the socio-economic impact of Cropland Agroforestry (CAF) on farmers' livelihood. The survey results reveal that CAF farmers' socio-economic status is better than that of Non-Cropland Agroforestry (NCAF) or monoculture farmers. This study finds that housing pattern, level of education, land and other physical assets are significantly different between CAF and NCAF farmers. The mean annual household income of the surveyed CAF farmers is Tk. 0.19 million which is significantly higher ($p < 0.05$) than that of the surveyed NCAF farmers. Household income also varies widely according to farm size and number of members in a household. The Weighted Mean Index (WMI) of five major indicators of farmer's household livelihood situation reveals that CAF farmer's household energy and food situation, affordability of education, medical and clothing expenditure is better than NCAF farmers. This study finds a statistically significant difference ($p < 0.05$) between CAF and NCAF farmers in case of these five major indicators. Therefore, this study suggests for planned expansion of cropland agroforestry for overall socio-economic development of the farmers.*

Keywords: Agroforestry, Cropland, Livelihood, Socio-economic condition, Farmer

1. INTRODUCTION

Cropland Agroforestry (CAF) is a traditional land use system in Bangladesh where tree species like date palm (*Phoenix sylvestris*), palmyra palm (*Borassus flabellifer*), babla (*Acacia nilotica*), mango (*Mangifera indica*), khoer (*A. catechu*), mahogany (*Swietenia mahogany*), jackfruit (*Artocarpus heterophyllus*), eucalyptus and sissoo (*Dalbergia sissoo*) grow naturally or planted on agricultural lands and are purposely retained and maintained by the farmers for different household utilities, products and also for cash income [1, 3, 13, 16]. Various patterns of cropland agroforestry systems are practiced in different agro-ecological regions of Bangladesh which reflects biophysical and social variations [31]. Trees are planted on the borders or within the field, systemically or at irregular intervals, usually with crops such as rice, wheat, pulse, jute, oilseed, sugarcane, vegetables and others, and farmers also grow shade-tolerant crops such as turmeric, ginger and aroid when trees have high canopy coverage (e.g. jackfruit, mahogany) [24].

CAF system provides enough food, timber, fodder, fruit, fuel wood, construction materials, raw materials and other products for forest-based small-scale enterprises and other cottage industries [3, 16, 28]. The best product having commercial value from cropland trees might be poles and pulpwood as these trees are mostly short-rotation species [15]. Trees in crop fields work as insurance in case of sudden crop failure or to support crops against environmental hazards and also to provide extra income from trees. Moreover, if there is a failure in one crop, the other crops would supplement the deficit. So, CAF is largely evolved with sustainability concerns - resiliency, diversity, and avoiding negative side effects in mind [9].

It is observed that on an average about 2 percent family income come from the CAF [13]. In a study of cropland agroforestry in Bangladesh it is found that about 46 percent of farmers generated cash income from selling trees and met expenses for purchase of land, bullocks and inputs for crops, supplemented expenses of marriage, household expenditure, and loan repayment [11]. In addition, a comprehensive survey on Jessore district reveals that about 43 percent of the household fuel needs are

met by tree products and about half of this comes from the CAF [2]. Besides fuel wood supplying for household cooking, CAF also provides environmental, economic and social benefits to the community [12] which ultimately boasts the sustainable livelihood strategies of the local people (Figure 1).

The forestry situation in Bangladesh reveals a dismal picture. Bangladesh has about 17 percent of forestland [8] but the actual tree covered area is only 6 to 7 percent at present [22] which is decreasing at an alarming rate due to overpopulation. Moreover, forests in Bangladesh have declined by 2.1 percent annually over the last three decades due to deforestation, illegal logging and harvesting, slash-and-burn agriculture, conversion into non-forest land for settlement, farming, recreation and industries [5]. So, it might be difficult to fulfill the requirements of the people's demand for fuel, fodder, timber and other necessities with the existing forest resources in Bangladesh. On the other hand, the demand of food crops has been increasing rapidly due to ever increasing population in Bangladesh. However, the country has only 7.63 million hectares (ha) of arable land and per person arable land is 0.05 hectares [35]. Due to over growing population, per capita land area is decreasing at an alarming rate of 0.005 ha/capita/year since 1989 [19]. This put heavy pressure on land for human habitation and crop production [15].

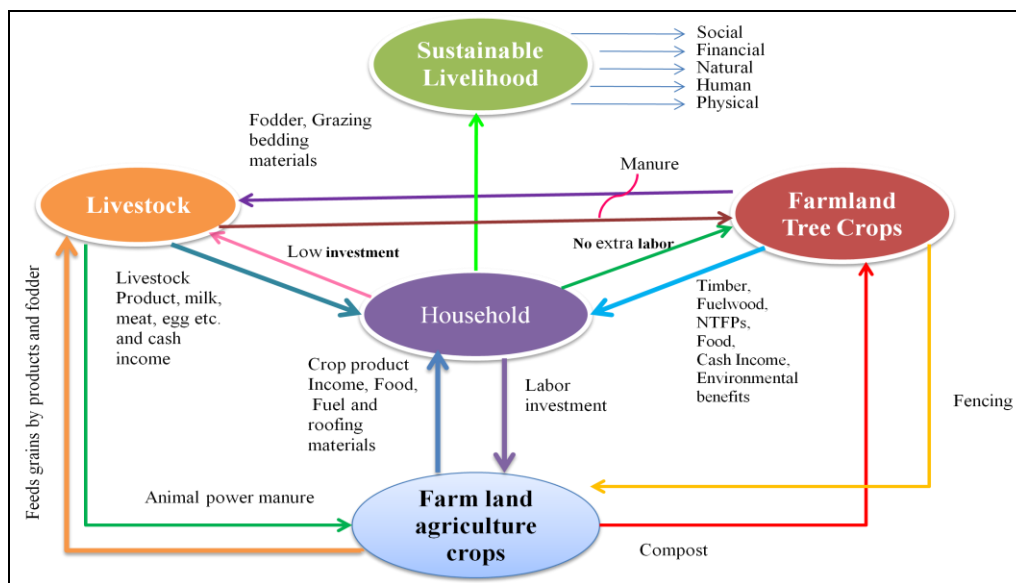


Fig1. Contribution of CAF on Sustainable Livelihood

Source: Authors' Compilation

In such circumstances, traditional land use pattern should be converted into sustainable land use, which will permit maintenance of productivity combined with conservation of the resources. CAF might be the best land-use system for sustainable livelihood in Bangladesh to cope with the present situation. It is a land based production system that is directly related to food security, employment, income opportunities and environmental issues. CAF also plays a vital role in rural socio-economic development as well as poverty reduction. Likewise, CAF practice increases yield and services of per unit agro-forest area. At present, people are practicing various CAF practices all over the country [4]. It is also intensively practiced in Jessore district [17]. Although several studies have been conducted on CAF practice from various perspectives, but no study is so far carried out specifically to ascertain the socio-economic impact of CAF on farmers' livelihood in the Jessore district. Therefore, this study is conducted in Jessore district of Bangladesh to know the socio-economic impact of CAF on farmers' livelihood.

2. MATERIALS AND METHODS

2.1. Study Area

The study is conducted in the Jessore district (Figure 2) of the south-west region of Bangladesh. It lies between latitudes 23⁰10'12"N to 23⁰17'0"N and longitudes 89⁰12'0"E to 89⁰20'0"E. The study area covers a total of 2,567 km² with a population of 2.74 million [7]. The mean family size is four with the sex ratio (male/female) of 1:0.94. Two persons per household are economically employed on an average in the study area. Agriculture is the main occupation for most inhabitants of the district. Rice, jute, pulse, oilseed, wheat, sugarcane and vegetables are the important agricultural crops of the

district. Agriculture plays an important role in rural livelihoods for both income and consumption of the people living in the area.

The study area enjoys a tropical monsoon climate with the lowest rainfall in Bangladesh. The monsoon usually starts in May and ends in late September. The annual rainfall within the tract varies from 1,400-1,800 mm. and the average daily temperature ranges from 12°C during December-January to about 31°C during May-August [7]. Four main seasons namely the dry or winter season (December to February), the pre-monsoon hot season (March -May), the monsoon or rainy season (June-September) and the post monsoon or autumn season (October -November) are recognized in the study area.

The area is situated in the high Ganges river floodplain [14] which is predominantly highland and medium highland. General soil types include calcareous dark grey floodplain soils and calcareous brown floodplain soils [5]. Soil pH ranges from 7.0 to 8.5 [32]. The highlands are flood-free, but other areas are shallow to deeply flooded during monsoon.

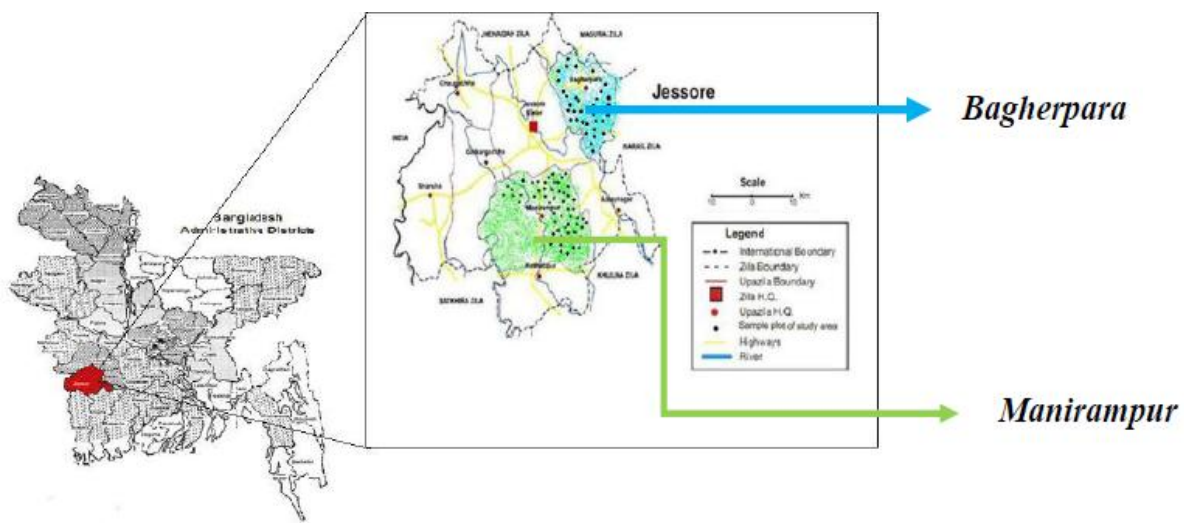


Fig2. Map of Jessore District

Source: Authors' Compilation

2.2. Sampling Design

This study follows a multistage random sampling procedure. Firstly, Jessore district (locally called zila) is purposively selected from the south-west region of Bangladesh. Consequently, out of 8 upazilas (sub-districts) in the Jessore district, two (*Manirampur* and *Bagherpara*) are randomly selected. Out of 17 unions of *Manirampur* and 9 unions of *Bagherpara* upazila, a total of four unions are selected randomly taking two from each upazila. From the four selected unions, a total of twelve villages are selected randomly taking three villages from each union. From these twelve villages, a total of 84 households are randomly selected. In selecting 84 households a control was imposed to make sure that half of the households are CAF practitioners and the rest half is Non-Cropland Agroforestry (NCAF) or monoculture practitioners.

2.3. Data Collection and Analysis

An intensive household survey is carried out with a questionnaire to fulfill the objectives of the study during June to July 2013. Besides, transect walks are carried out to observe the farm behavior, landscape, practices and to analyze the actual practices in the natural settings. This is a useful method which is used in ecological studies to estimate the population of animals [33]. Collected data are initially entered in computer carefully using Microsoft Excel. Some data are checked randomly against original completed questionnaires to detect entry errors. Accordingly, the detected errors are corrected for analysis.

Descriptive statistical analysis including frequency distribution, percentage, cross tabulation, mean and standard deviation (SD) are used for data analysis to summarize the farmers' socio-economic characteristics and farm specific characteristics. Pearson's chi-square test (χ^2) is used to test the significance (differences) for some of the categorical variables, where necessary. In order to identify the variations, sample means were compared by performing independent t-test.

This study classified surveyed farms into three categories: small (< 0.20 ha), medium (between 0.20 to 0.40 ha) and large (>0.40 ha) whereas farmers are classified as four income groups. Income group 1 includes less than Tk. 0.10 million yearly household income; group 2 includes Tk. 0.11 to 0.30 million; group 3 includes Tk. 0.31 to 0.50 million and group 4 includes Tk. more than 0.50 million.

The commonly used technique for valuing agriculture and tree crops is the income approach, where the physical production of goods and services is valued using actual or surrogate market prices of the resource [34]. Information is collected on all the sources of income of the households. Each respondent provided an estimate of how much yield was collected and sold from each sources of income in the year prior to survey, i.e. 2012. Moreover, standing timber value of trees is also considered to calculate yearly income of tree crops. However, intangible benefits of trees like biodiversity conservation, mitigation to climate change, environmental benefits and natural hazard protection are not considered in this calculation.

Five major indicators of farmer’s household livelihood situation have been taken into consideration to evaluate overall household situation. A Weighted Mean Index (WMI) has been constructed for each of the indicators, and finally an aggregate WMI is determined to examine the overall situation. Hereunder, a likert scale of five points is used to measure the farmers’ satisfaction level of livelihood condition and affordability level of household cost. Aggregate WMI is calculated through equation 1 following [26].

$$WMI = \frac{w_1f_1+w_2f_2+\dots+w_nf_n}{f_1+f_2+\dots+f_n} = \frac{\sum w_i f_i}{\sum f_i} \tag{1}$$

Where, *WMI* = Weighted Mean Index

w_i= Assigned weight for a particular class under satisfaction scale

f_i= Corresponding frequency of that class

3. RESULTS AND DISCUSSION

3.1. Housing Pattern of the Respondents

In terms of housing pattern of the respondents, there is a significant difference between CAF and NCAF farmers. Authors found that 86 percent of CAF families have *Paka* house with tin roof, whereas only 55 percent NCAF families have this type of house. About 91 percent CAF farmers and 82 percent NCAF farmers have their own tubewells. Besides, the percentage of CAF families is higher than NCAF families in case of *Paka* toilet, *Paka* and *Kacha* house with tin roofs (Table 1).

From the independent t test analysis it is found there is a significant difference between CAF and NCAF farmers in case of *Paka* house with tin roof and *Kacha* house at 5 percent level of significance and in case of *Paka* toilet at 10 percent level of significance (Table A1 of Annex). It is observed that most of the CAF families have better housing pattern than NCAF. Survey data also reveals that CAF farming system provides a better opportunity to uplift the living standard of the people. Usually people’s living standard depends on income. When income increases his/her living standard also improves. According to the survey data, CAF practitioners’ income level is comparatively higher than that of NCAF and hence they can improve their living conditions through the extra income.

Table1. *Housing Pattern of the Respondents*

Housing pattern	CAF Practitioners (N=42)			NCAF Practitioners (N=42)		
	Mean	SD	Percentage	Mean	SD	Percentage
<i>Kacha</i> house (No.)	0.29	0.50	26	0.74	0.89	50
<i>Kacha</i> + Tin roof house (No.)	0.93	0.71	71	1.21	1.16	64
<i>Paka</i> + Tin roof house (No.)	1.38	0.88	86	0.90	1.05	55
<i>Paka</i> + Concrete roof house (No.)	0.19	0.39	19	0.10	0.29	9
<i>Paka</i> Toilet (No.)	0.74	0.49	71	0.55	0.50	55
<i>Kacha</i> Toilet (No.)	0.31	0.52	29	0.45	0.50	45
Tubewell (No.)	0.93	0.34	91	0.90	0.53	82

Source: *Authors’ Compilation based on Field Survey (2013)*

3.2. Land Asset of the Respondents

Field level data reveals that the average CAF farm size is 0.22 ha (SD=0.18, N=42) and it is 0.51 ha (SD=0.27, N=42) for NCAF farm (Table 2) which indicates that CAF is a popular and dominant

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farming practice in the study area. In terms of total land asset, the average land size per household is 1.02 ha for CAF farms and it is 0.51 ha for NCAF farms which signals that CAF farmers possessed more land assets than NCAF and the said mean difference is statistically significant ($p < 0.05$) at 5 percent level of significance (Table A1 of Annex). Similarly, in case of Yemen it is found that the land size is significantly higher for CAF farms compared to NCAF farms [30].

Table2. Land Asset of the Respondents

Land asset	CAF Practitioners (N=42)		NCAF Practitioners (N=42)	
	Mean	SD	Mean	SD
Total land (ha)	1.02	0.86	0.57	0.69
Arable land (ha)	0.74	0.68	0.51	0.27
Farm land (ha)	0.22	0.18	0.51	0.27

Source: Authors' Compilation based on Field Survey (2013)

3.3. Livestock Asset of the Respondents

Although sale of crops and non-farm income are seen as main source of income for most households, farmers also get income from sale of livestock. Most households rear different kinds of livestock including chicken, cattle, goat and duck. Livestock are reared for two major reasons: income and food. According to the survey findings, some farmers reared them for manure or as a risk management measure. In addition, cattle and goat are reared as a source of income or form of payment for hired labor. Cattle are also reared for using in agriculture cultivation. Those cattle are used on own farm as well as to hire out for raising income.

Table3. Livestock Asset of the Respondents

Livestock assets	CAF Practitioners (N=42)			NCAF Practitioners (N=42)		
	Mean	SD	Percentage	Mean	SD	Percentage
Cattle (No.)	2.67	2.04	79	2.05	1.60	76
Goat (No.)	1.71	2.20	45	1.36	1.86	45
Poultry (No.)	7.05	6.43	76	9.09	1.21	81

Source: Authors' Compilation based on Field Survey (2013)

This study finds that CAF farmers have 3 cattle per household, whereas NCAF farmers have 2 cattle per household on an average (Table 3). Average poultry number is 7 for CAF households and 9 for NCAF households. The survey data reveals that there are sufficient differences of livestock numbers between CAF and NCAF members. However, this study didn't find any statistically significant differences in case of livestock numbers between the two categories of households. In contrast, in case of Yemen, it is found that the number of livestock is significantly higher for CAF farms than for NCAF farms [30].

3.4. Physical Asset of the Respondents

Physical asset is a source of coping shocks in the rural livelihoods. It is also a good indication of life standard. People having more physical assets reveal that he/she enjoys more social status than others.

Table4. Physical Asset of the Respondents

Physical asset	CAF Practitioners (N=42)			NCAF Practitioners (N=42)		
	Mean	SD	Percentage	Mean	SD	Percentage
Television (No.)	0.57	0.52	55	0.38	0.49	38
Radio (No.)	0.10	0.29	8	0.14	0.35	14
Mobile Phone (No.)	1.98	0.55	100	1.81	1.67	95
Bi-cycle (No.)	0.86	0.61	74	0.71	0.56	66
Motor cycle (No.)	0.24	0.43	24	0.10	0.30	10
Power-tiller (No.)	0.12	0.33	12	0.05	0.21	5
Spray-machine (No.)	0.26	0.44	26	0.32	0.47	32
Shallow machine (No.)	0.24	0.48	21	0.17	0.44	15
Paddy thrashing machine (No.)	0.33	0.47	33	0.22	0.47	20

Source: Authors' Compilation based on Field Survey (2013)

Authors found that 55 percent CAF farmers have television whereas 38 percent NCAF farmers have television (Table 4). Again, from Table 4 it is seen that CAF farmers possessed more physical assets

than NCAF farmers except radio and spray machine. There are significant differences ($p < 0.10$) in cases of television and motorcycle at 10 percent level of significance between the two categories of households (Table A1 of Annex). But there are no significant differences in cases of other physical assets between the two categories of households.

3.5. Level of Education of the Respondents

The level of education among CAF farmers is generally high. About 69 percent of respondents have formal education to the secondary level while 12 percent are illiterate. The total number of CAF practitioners who are literate constitutes 88 percent (Figure 3). In contrast, the level of education among NCAF practitioners is comparatively low. About 69 percent of the respondents have formal education to the secondary level while 24 percent are illiterate. The total number of NCAF practitioners who are literate constitutes 76 percent. Moreover, the level of education is found to be significantly higher for CAF farms than for NCAF farms (Table A1 of Annex). However, in case of Yemen, it is found that the level of education is not significantly higher for CAF farms than for NCAF farms [30].

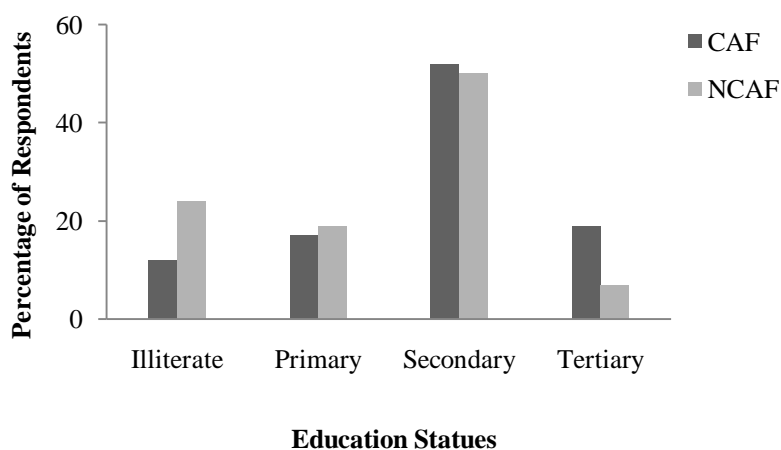


Fig3. Level of Education of the Respondents

Source: Authors' Compilation based on Field Survey (2013)

3.6. Economic Statuses of the Respondents

The income and expenditure data of CAF and NCAF farmers is shown in Table 5 which reveals significant differences between the two categories of households.

Table5. Economic Status of the Respondents

Indicators	CAF	NCAF
Mean Annual Income (BDT in million)	0.19	0.13
Standard Deviation	0.10	0.07
Minimum	0.08	0.07
Maximum	0.56	0.45
Mean Annual Expenditure (BDT in million)	0.12	0.09
Standard Deviation	0.02	0.03
Minimum	0.08	0.06
Maximum	0.18	0.20

Source. Authors' Compilation based on Field Survey (2013)

It is found that mean income of CAF household is Tk. 0.19 millions and Tk. 0.13 millions for NCAF household in the study area (Table 5), i.e. CAF households' mean yearly income is higher than NCAF households. The literatures [17, 18, 21, 28, 29 and 30] also find that income of farmers has been increased by practicing CAF over pure agriculture. It is also found that the agricultural system with CAF was more profitable than the conventional subsistence farming system in the Middle Hills of Nepal [25].

The test results indicate that the difference between mean income considering CAF and NCAF farmers is significantly different at 5 percent level of significance. Moreover, CAF has enhanced expenditure of the respondents, which is also statistically significant at 5 percent level of significance

(Table 6). It means that CAF paved the way to attain higher income and expenditure that leads to improve socio-economic condition and livelihood of farmers.

Table6. Test of Differences between Samples Mean of CAF and NCAF

t-test for Equality of Means							
Variables	F	t-value	d. f.	Sig. (2 tailed)	Mean differences	Std. error difference	p-value
Income	3.23	-3.02	82	0.003	-0.06	0.019	0.05
Expenditure	1.49	-3.86	82	0.000	-0.02	0.006	0.05

Source: Authors' Compilation based on Field Survey (2013)

3.7. Cross-tabulation of CAF and NCAF Income Group and Farm Size

It is clear that most of the CAF small farmers belong to income group 2 (Table 7). It indicates that CAF farmers have more economic power than NCAF farmers (Table 8). Most of the NCAF farmers' yearly income is less than Tk. 1 lakh that means they are not very affordable to maintain their household cost, whereas CAF farmers are well enough to meet their living cost.

Table7. Cross-tabulation of CAF Farmers: Income Group and Farm Size

CAF Farm Size	CAF Income Group (N=42)				Total
	Group 1	Group 2	Group 3	Group 4	
Small farm	2	25	1	0	28
Medium farm	0	6	1	0	7
Large farm	0	3	3	1	7
Total	2	34	5	1	42

Table8. Cross-tabulation of NCAF Farmers: Income Group and Farm Size

NCAF Farm Size	NCAF Income Group (N=42)				Total
	Group 1	Group 2	Group 3	Group 4	
Small farm	4	1	0	0	5
Medium farm	8	4	0	0	12
Large farm	11	12	2	0	25
Total	23	17	2	0	42

Source: Authors' Compilation based on Field Survey (2013)

3.8. Inter-relationship between CAF Income Group and Farm Size

From the chi-square test, authors find that there are significant differences between different income group and farm size, but both are highly correlated with one another (Table 9 and 10). It reveals that income depends on farm size. If farm size increases then farmers' income also increases. Accordingly farmers can earn more money from selling diversified forest and agriculture products which thus lead to a sustainable life with high social status. Similarly, literature also finds that farm size is significantly positively related to farmers' income [30].

Table9. Chi-Square Test

	Value	d. f.	Sig. (2-sided)
Pearson Chi-Square	14.81 ^a	6	0.02
Likelihood Ratio	12.62	6	0.05

a. 9 cells (75.0 percent) have expected count less than 5. The minimum expected count is 0.17.

Table10. Correlation between Income Group and Farm Size

Indicator		CAF Farm Size	CAF Income Group
CAF Farm Size	Pearson Correlation	1	0.53**
	Sig. (2-tailed)		0.000
	N		42
CAF Income Group	Pearson Correlation	0.53**	1
	Sig. (2-tailed)	0.000	
	N	42	

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

Source: Authors' Compilation based on Field Survey (2013)

3.9. Impact of CAF on Livelihood of Households

Table 11 reports that CAF household energy and food security situation is very good whereas NCAF is above average. From the WMI, authors found that affordability of maintaining the school fees and learning materials, clothes and medical treatment/drugs in the household of CAF is better than NCAF farmers.

Table11. *Weighted Mean of Livelihood of Households*

Indicators	Weighted Mean	
	CAF	NCAF
Household Energy Situation	4.52	3.83
Household Food Security Condition	4.36	3.66
Household Education Expenditure Affordability	3.83	3.52
Household Clothing Expenditure Affordability	3.86	3.57
Household Medical Expenditure Affordability	3.78	3.52

Source: *Authors' Compilation based on Field Survey (2013)*

From the independent t-test of the weighted mean (WM) of CAF and NCAF household, it is found that there is a clear difference between two categories of farmers. CAF farmers livelihood situation is significantly higher ($p < 0.05$) than NCAF farmers (Table 12). Similarly, the literatures find the evidence of agroforestry's impact on farmers' socioeconomic status in Tangail [36], Jamalpur [10], Mymensingh [20], and Kishorgonj [23] districts. In addition, literature also finds that agroforestry income maintains basic household needs, provides food security and fuelwood, and contributes to healthcare, housing and sanitation conditions, and meeting educational expenses [27].

Table12. *Test of Differences between WM of CAF and NCAF*

Variable	t test for Equality of Means				Mean differences	Std. difference	Error	p-value
	F	t-value	d .f.	Sig.(2 tailed)				
Weighted Mean	14.63	2.74	8	0.03	0.45	0.16		0.05

Source: *Authors' Compilation based on Field Survey (2013)*

4. CONCLUSION

Introduction of CAF in crop fields brings significant change in the agricultural farming systems among farming communities in Jessore district and affects farming households. In most cases, CAF have been developed in high lying crop-fields, fallow lands and in some cases low lying rice fields. CAF allows the growth of multiple crops simultaneously and provides several livelihood benefits to farming households. So, it is an integrated production system, which is found to be an important source of food, fuelwood and direct cash income for the households. When income increases, a farmer's living condition also improves. The authors find that CAF has a significant impact on the farmers' livelihoods. Moreover, it is also found from literature that CAF has a significant impact on poverty reduction because of its multipurpose uses. In addition, the findings of this paper act as guidance for policy makers to design the necessary support measures to increase farm income as well as livelihood in the study area. Therefore, it suggests for planned expansion of cropland agroforestry for overall socio-economic development of the farmers.

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ANNEX

TableA1. Test of Differences between Sample Mean of CAF and NCAF

Variables Name	F	t test for equality of means					p-Value
		t-value	d. f.	Sig.(2 tailed)	Mean differences	Std. Error Difference	
Television	2.18	-1.68	82	0.096	-0.19	0.11	0.10
Paka toilet	3.41	-1.74	82	0.085	-0.19	0.11	0.10
Paka+ tin roof	0.41	-2.24	82	0.028	-0.48	0.21	0.05
Kacha house	13.96	2.87	82	0.005	0.45	0.16	0.05
Motorcycle	14.001	-1.77	82	0.081	-0.14	0.08	0.10
Total land	3.84	-2.59	82	0.011	-0.44	0.17	0.05
Education	0.07	-2.005	82	0.048	-1.93	0.96	0.05