



Research article

Rural women participation in farm and off-farm activities and household income in Bangladesh

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ABSTRACT

The present study was mainly an impact of farm and off-farm activities on household income and participation of rural women in the Thakurgaon district of Bangladesh. The specific aim was to compare the rural women's participation considering their socioeconomic characteristics, income contribution to household income, and its influencing factors. An Independent Sample T-test was used to compare socioeconomic differences. Pearson's correlation test was used to determine the relationship between women's personal income and household income. The propensity Score Matching (PSM) model was used for impact evaluation of off-farm activities. The result of the t-test showed that off-farm activities were significantly ahead for women from the farm women in terms of socioeconomic variables. There was positive and a strong correlation between women's personal income from off-farm activities and their household income. The result of PSM shows that off-farm activities have a positive and significant impact on rural women's income. Estimation of the binary Probit model and marginal effects of related explanatory variables revealed that educational status, family size, work experiences, personal income, saving, and training, significantly affected rural women's involvement in off-farm activities. Therefore, to increase the pace of work, the participation of rural women in off-farm activities needs to be made more effective and efficient, for which government and non-government organizations need to take necessary steps in area-based development (such as work environment, credit facilities, communication, infrastructure, etc.).

1. Introduction

Household income is generally defined as the combined gross income of all household members above a specified age. It includes wage, salary, and self-employment earnings; social security, pension, and other retirement income; investment income; welfare payments, and income from other sources. A household is a family or social unit living together or everything related to the actions of households. It consists of one or several persons (men, women, and children) who live in the same dwelling and share meals. Traditionally, women are the primary decision-makers for laundry, cleaning, and cooking for about 62% of households (Brenan, 2020). Nowadays, women's participation in the labour force is changing worldwide.

In Bangladesh, women constitute almost half of the total population, playing a vital role in the economic development of the family and the nation. Traditionally, rural women in Bangladesh have been playing a crucial role in a wide range of income-generating activities in agriculture and almost every aspect of our society. They are silent workers and

fundamental contributors to the rural economy. They are found to have a statistically significant effect on economic activities (Khan and Rahman 2016). Also, the participation rate of rural women labour forces is slightly higher (33.7%) than that of urban women labour forces (32.9%) (Bangladesh Bureau of Statistics, BBS, 2017). The contribution of rural women to the economy is often appreciated but not widely recognized in Bangladesh (Chowdhury et al., 2009). Traditionally, women have played essential participation in agriculture-as farmers, co-farmers, wage labourers, and managers of the farm (Lal and Khurana, 2011). Previously women's farming activities were restricted to homestead production and post-harvest operations; however, in recent years, they have been mostly involved in animals and poultry rearing activities besides crop production activities (Hossain and Jaim, 2011). The key concern is the share of women engaged in salaried jobs; only close to 15% of rural women are engaged in waged or salaried employment. The rest of the works-both in terms of household chores and off-farm activities by women largely remains unaccounted for (Fentie and Rao, 2015).

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Researchers have tried to differentiate between the reasons why rural women are being forced or interested in working outside the home, some of which are mentioned here. Women in low-income households find work outside of their homes due to severe economic pressures, while women in middle- and high-income households seek work in order to decrease self-dependency and improve their living standards (Chowdhuri et al., 2009). A family with a lower income is more likely to increase their family income by involving female members in farm and off-farm activities. On the other hand, a family with a high income might reduce the necessity of augmenting household income by including women in the labour force (Kazi and Raza, 1986). Moreover, with the reduction of physical barriers (for example, the improvement of roads and other rural infrastructures) and the development of a modern communications/information system (for example, mobile phones and the internet), the connection between rural and urban areas has become easier to make (Sen et al., 2021) for women participation in rural off-farming activities. Despite significant improvements in female labour market retention, women still earn considerably less than men (Fransen et al., 2011). As a result of personal, family, economic, and social development, rural women today are involved in many productive and economically profitable activities, which are nationally and internationally recognized. So, the question now is, does the participation of rural women in farm and off-farm activities really lead to socio-economic development? If so, which farming is more suitable for rural women? How much can this diversity of women's livelihood contribute to their family income? And above all, what factors affect family income? A large number of empirical studies show that rural women play important roles in strengthening their household income through livelihood diversification. Reardon (1997) and Turner et al. (1993) have highlighted the importance of earnings from off-farm activities. The livelihood diversification activities are of increasing importance for women empowerment (Bryceson, 1996, 2000; Bryceson and Jamal, 1997) through additional income-earning and improvements in family welfare (Ellis, 1999). Some studies have been conducted in South Asia that economic empowerment has been the entry point for the overall empowerment of women if they are organized under a common platform (Carr et al., 1996). A limited number of studies (Farid et al., 2009; Hossain et al., 2013; Nawaz, 2020) were conducted on rural women's participation in income-generating activities. Chikoya (2016) determined the impact of women's participation in income-generating activities on household income. Hafeez and Ahmed (2002) identified the different socio-economic and demographic factors, which influence the decision of educated married women about participating in the labour market in Pakistan. Khadim and Akram (2013) determined the factors affecting female labour force participation in the formal sector. Siddique et al., (2009) found that the majority of the female respondents were engaged in vegetable picking, animal caring, etc., in Pakistan. Very few studies (Roy et al., 2017; Chowdhury et al., 2009; Hossain et al., 2013) have shown the contribution of rural women in their family income and decision-making process through statistical comparisons in many developing countries, which is almost absent from the field of rural women engaged in farm and off-farm activities in Bangladesh. However, none of these studies analysed the impact of farm or off-farm activities of rural women on household income using the propensity score matching method. Furthermore, it has not been previously analyzed which income-generating activity between farm and off-farm activity successfully leads to an increase in family income and socio-economic development of rural women, which the present study seeks to highlight. Besides, no study has been found to determine the factors that affect the family income of rural women participating in farm and off-farm activities, which is highly successful in this regard. Therefore, in terms of achieving the goals of the study, the participation of rural women in farm and off-farm activities was analyzed, especially their socio-economic status and level of participation, their contribution to family income, and what factors influence the possibility of women's participation in off-farm income. The survey will suggest that rural women need to increase their family income and well-being by further strengthening their participation in earning activities.

2. Materials and methods

2.1. Conceptual framework of women's participation

The study incorporates concepts of women's participation with a household perspective to analyze the household income for not only strengthening their household income but also improving household well-being through livelihood diversification as farm and off-farm activities (Figure 1). Transforming social structures and processes directly influences livelihood strategies as well as livelihood outcomes of rural women.

Household perspective and background characteristics of rural women are key determinants of livelihood diversification. In other words, rural women are taking up farm activities as well as off-farm activities to determine their time and livelihood, which is adding extra income to their household. As a result, their contribution to the family is increasing as well as strengthening the household income, directly and indirectly, the overall well-being of the family has come to the fore. This overall well-being ensures family education, health, food security, housing, and other social activities that need further research.

2.2. Selection of sample size and sampling technique

During the 1990s, off-farm activities assumed an increasingly important role in the rural economic growth of Bangladesh. According to Labour Force Survey (LFS) data, employment in the agricultural sub-sector declined from 63% in 1995/96 to 40.60% in 2016/17 (Bangladesh Economic Review, BER, 2021). On the other hand, off-farming employment rose from 39% to 46.3% (Bangladesh Bureau of Statistics, BBS, 2021). Based on this, primary data is used to carry out the highlighted objectives. In doing so, a multistage sampling technique was followed to select the samples. At first, Ranisankail Upazila under Thakurgaon District, the north-western side of Bangladesh, was selected for the convenience of the study (Figure 2). Because it is one of the major agriculture-based areas in Bangladesh where the primary livelihood of women was agriculture, but with the passage of time, women are gradually adopted off-farm activities for their livelihood. Therefore, they have been selected to analyze how these activities increase their family income. After that, seven villages such as Gogor, Sandharoy, Kolinapara, Moholabari, Rangatungi, Chopra, and Gonosampur were selected, where 400 women were identified who were involved in different farm and off-farm activities. Rural households with no cultivable land mainly depend on their income from farming and off-farming employment. Farming employment may be agricultural wage labour or farming as rice processing and selling, hotel workers, pita maker, and vegetable shopkeepers, etc. On the other hand, off-farming employment may be of different types as a carpenter, mason, tailor, home garments, grocery shopkeepers, etc. Then, by using a simple random sampling technique, 30% of rural women were selected due to lack of time, financial support and contact. A total of 120 women were interviewed where to measure equal participation, 60 rural women from farming activities and 60 from off-farming activities were selected. The draft interview schedule was pre-tested with 20 women from the study area. The pre-test helped the researcher find faulty issues in the draft schedule, and necessary corrections and modifications were made based on its result. Hence, the researchers collected necessary primary data from the sample women via a structured questionnaire through a face-to-face interview where all the women willingly participated. The data collection process covered three months period from September to November 2019.

2.3. Analytical techniques

Analytical techniques enable researchers to examine the complicated relationship between variables. The collected data was analyzed based on the objectives of the study by using descriptive statistics and statistical analysis. To make a comparison of farm and off-farm activities

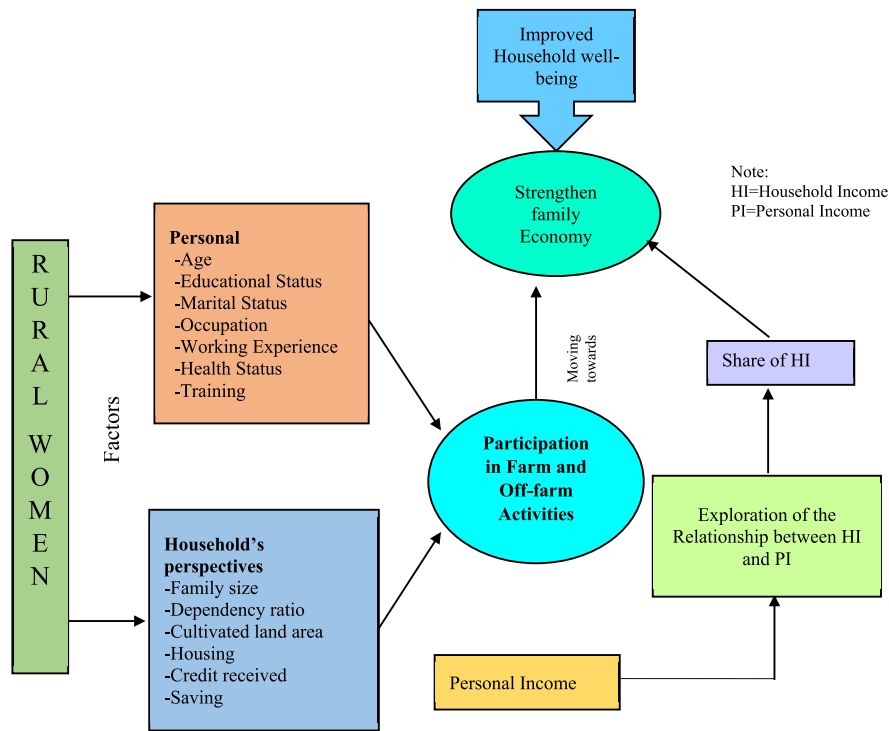


Figure 1. Conceptual framework of women participation in farm and off-farm activities for household well-being, Source: (Author's contribution).

considering the socioeconomic characteristics of rural women, an Independent Sample t-test was used.

Some socioeconomic characteristics such as age of the respondents, educational level, family size, annual household income, household expenditure, housing condition, and health situation, etc. were considered.

2.4. Pearson's correlation analysis

Pearson's correlation coefficients, also known as Pearson R statistical test was used to measure how strong a relationship was between household income and women's personal income. To do this, equation number 1 was used as follows:

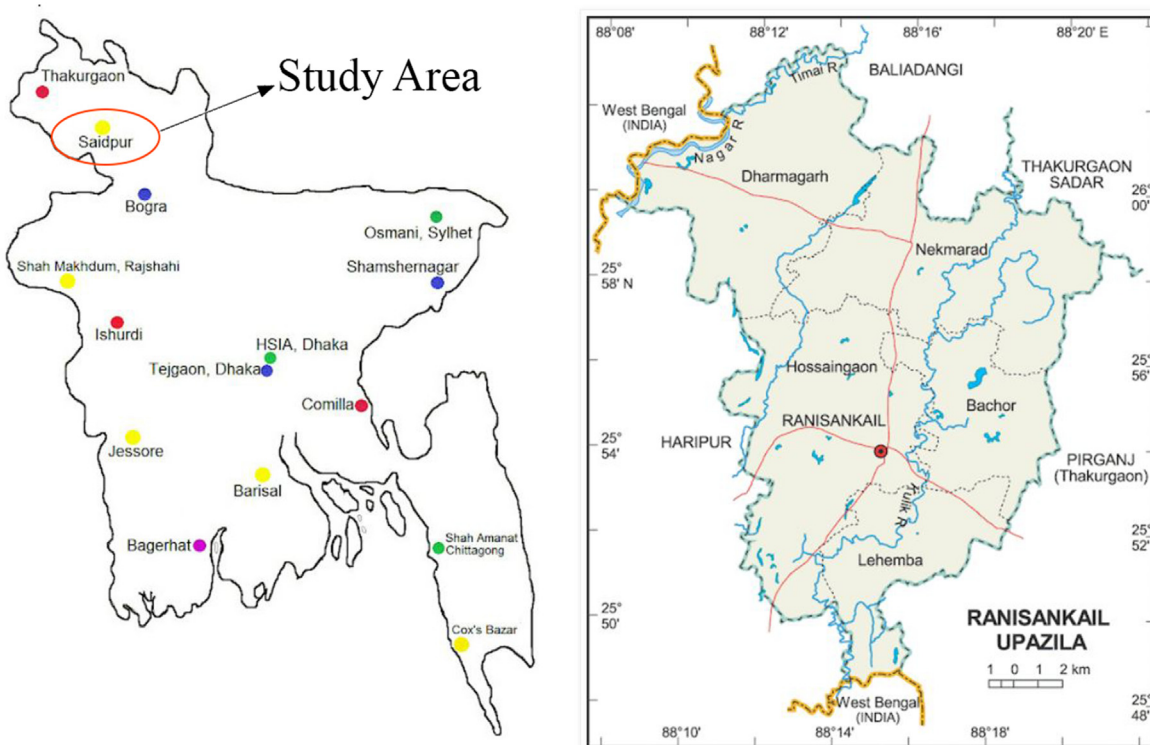


Figure 2. Map of the study area. Source: Google map, 2020–2021.

$$r = \frac{n(\sum xy - (\sum x)(\sum y))}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \tag{1}$$

Here

r = correlation coefficient, x = household income, y = women's personal income. r returns a value between -1 to 1, with a value of -1 meaning a strong negative relationship between the variables, 0 being no correlation, and +1 meaning a strong positive correlation between them.

2.5. Propensity score matching (PSM) model

The study considered rural women involved in off-farm activities as the treatment group, and those involved in farm activities for their livelihood as the control group. According to Rosenbaum and Rubin (1983), PSM enables the correction of selection bias concerning observable characteristics that may affect women's participation in off-farm activities. Matching is an essential estimation for treatment effect using observational data (Baser 2006). Propensity score estimation aims to balance the covariate distribution in the treated and control groups (Rosenbaum and Rubin 1983). In order for PSM to be valid, balancing properties need to be satisfied which indicates that two women groups have an equal probability of participation (off-farm) and non-participation (farm) in livelihood activities. The idea behind the balancing test was to check whether the propensity score was an adequate balancing score, that is, to check to see if, at each value of the propensity score, X has the same distribution for the treatment and control groups (Lee 2013). The propensity score was estimated by a binary choice model, which, in this paper, was represented by a binary probit model. Once the propensity score (pscore) was estimated, the data was split into equally spaced pscore interval, implying that, within each of these intervals, the mean pscore of each conditioning variable was equal for the treated and controlled rural women, known as the balancing property. A further requirement for the propensity score was the common support or overlap condition. It implies that farms with the same X values had a positive probability of being both participant and non-participant. Common support is written as follows with Eq. (2):

$$(Overlap) \quad 0 < P(I=1|X) < 1 \tag{2}$$

There were many ways (methods) to estimate ATT. To maintain consistent matching between the results, three different techniques for the estimation of the propensity score matching were employed, namely, nearest neighbor (NNM), radius (RM), and kernel (KM). Nearest neighbor matching set was written as with Eq. (3);

$$C(i) = \min_j \|p_i - p_j\| \tag{3}$$

Where C(i) was the set of control units matched to the treated unit i with an estimated value of the propensity score of p_i. Let T the set of treated and C the set of control units, and Y_i^T and Y_i^C were the observed outcomes of the treated and control units respectively. Then Nearest Neighbor Matching (NNM) was written as follows with Eq. (4);

$$NNM = \frac{1}{N^T} \sum_{i \in T} Y_i^T - \frac{1}{N^C} \sum_{j \in C} w_j Y_j^C \tag{4}$$

Where the weights w_j were defined as. w_j = ∑_i w_{ij}

In general, Kernel is the simpl density function. Here all the observations in the comparison group inside the common support region were used, the comparison unit from the control unit the lower the weight. The counterfactual outcome for participants i was computed as a kernel-weighted average of the outcomes of all non-participants. The weight assigned to non-participants j was in proportion to how close to participants i. Here the neighborhood was as follows with Eq. (5):

$$C(p_i) = \{j | h > \|p_i - p_j\|\} \tag{5}$$

Where h was the tolerance level.

Heckman, Ichimura and Todd (Heckman et al., 1998) described the kernel matching methods as follows with Eq. (6);

$$E(\Delta Y) = \frac{1}{N} \sum_{i \in T} \left[Y_{i,1} - \frac{\sum_{j=1}^{N_i^C} Y_{j,0} K \left(\frac{P(X_{j,0}^i) - P(X_{i,1})}{bw} \right)}{\sum_{j=1}^{N_i^C} K \left(\frac{P(X_{j,0}^i) - P(X_{i,1})}{bw} \right)} \right] \tag{6}$$

Where T was the set of observations who were in the program (treatment group) and N was the number of treated cases; Y_{i,1} and X_{i,1} were the dependent and independent variables for the ith treated case; Y_{j,0} and X_{j,0} were the dependent and independent variables for the jth comparison/control case that was within the neighborhood of treatment case i, i.e., for which |P(X_{j,0}ⁱ) - P(X_{i,1})| < bw/2; N_i^C was the number of comparison cases within the neighborhood of i; K(•) was a kernel function; and bw was a bandwidth parameter. In practice, the choice of K(•) and bw was somewhat arbitrary.

In Radius matching (Dehejia and Wahba, 2002) Eq. (7) is as follows:

$$C(i) = \{p_j : \|p_i - p_j\| < r\} \tag{7}$$

Here treated 'i' was matched with all control units' propensity score which falls within the same caliper (radius) r. Functionally the Radius matching method was as follows with Eq. (8);

$$R^M = \frac{1}{N^T} \sum_{i \in T} Y_i^T - \frac{1}{N^C} \sum_{j \in C} w_j Y_j^C \tag{8}$$

Where the weights w_j were defined as. w_j = ∑_i w_{ij}

2.6. Probit analysis

In addition to the descriptive analysis, maximum likelihood estimation with the Probit model was used to ascertain the determinants of farm and off-farm activities. Probit regression was employed to model binary outcome variables (0/1). The inverse standard normal distribution is shown as a linear combination of the predictors in the model. Econometrically, the model can be expressed as follows with the equation number 9:

$$\Pr(Y = 1|X) = \Phi(X^T \beta) \tag{9}$$

Where Pr represents the probability. Φ denotes the Distribution Function of the standard normal distribution, β stands for unknown parameters that are estimated by maximum likelihood.

Assuming there is an auxiliary random variable, the Probit regression can be regarded as a latent variable model with the equation number 10;

$$Y^* = X^T \beta + \epsilon \tag{10}$$

Where ε ~ N(0, 1). Y indicates if the latent variable is positive.

$$\begin{pmatrix} 1 & Y^* > 0 \\ 0 & \text{Otherwise} \end{pmatrix} = \begin{pmatrix} 1 & \epsilon < X^T \beta \\ 0 & \text{Otherwise} \end{pmatrix}.$$

By Symmetry of the normal distribution, the equivalence of both models above can be presented as follows with Eq. (11);

$$\Pr(Y = 1|X) = \Pr(Y^* > 0) = \Pr(Y^T \beta + \epsilon > 0) = \Pr(\epsilon > -X^T \beta) = \Pr(\epsilon < X^T \beta) = \Phi(X^T \beta) \tag{11}$$

2.6.1. Model estimation

Considering data set $\{Y_i, X_i\}_{i=1}^n$ comprises n independent units conforming to Eq. (12), for each observation, conditional on the vector of inputs is as follows with Eq. (13);

$$\Pr(y_i = 1|x_i) = \varnothing(x'_i\beta) \tag{12}$$

$$\Pr(y_i = 0|x_i) = 1 - \varnothing(x'_i\beta) \tag{13}$$

Where x_i represents a vector of $K \times 1$

Accordingly, the probability of each observation (y_i, x_i) is as follows with Eq. (14)

$$L(\beta_i y_i, x_i) = \varnothing(x'_i\beta)^{y_i} [1 - \varnothing(x'_i\beta)]^{(1-y_i)} \tag{14}$$

If $y_i = 1$ the $L(\beta_i y_i, x_i) = \varnothing(x'_i\beta)$ and if $y_i = 0$, then $L(\beta_i y_i, x_i) = 1 - \varnothing(x'_i\beta)$

Since observations are not related, the probability of the whole sample is equal to the total of the probabilities of each observation presented in Eq. (15);

$$L(\beta_i Y, X) = \prod_{i=1}^n \left(\varnothing(x'_i\beta)^{y_i} [1 - \varnothing(x'_i\beta)]^{(1-y_i)} \right) \tag{15}$$

Therefore, the joint log-likelihood function is specified as Eq. (16);

$$\ln L(\beta_i Y, X) = \sum_{i=1}^n y_i \ln \varnothing(x'_i\beta) + (1 - y_i) \ln(1 - \varnothing(x'_i\beta)) \tag{16}$$

Asymptotic distribution for $\hat{\beta}$ can be stated as Eqs. (17) and (18);

$$\sqrt{n}(\hat{\beta} - \beta) \xrightarrow{d} N(0, \Omega^{-1}) \tag{17}$$

Where

$$\Omega = E \left[\frac{\varphi^2(X'\beta)}{\varnothing(X'\beta)(1 - \varnothing(X'\beta))} XX' \right], \widehat{\Omega} = \frac{1}{n} \sum_{i=1}^n \frac{\varphi^2(x'_i\hat{\beta})}{\varnothing(x'_i\hat{\beta})(1 - \varnothing(x'_i\hat{\beta}))} x_i x'_i \tag{18}$$

Moreover, $\varphi = \varnothing'$ is the likelihood of standard normal distribution. Therefore, participating in farm and off-farm activities by rural women can be expressed as follows with Eq. (19).

$$\begin{aligned} \text{Farm or off - farm activities} &= \varnothing(\beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 \\ &+ \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9) \end{aligned} \tag{19}$$

Where β_1, \dots, β_9 = coefficients, x_1 = age, x_2 = education (categorical), x_3 = family size, x_4 = working experience, x_5 = housing condition (categorical), x_6 = personal income, x_7 = savings (categorical), x_8 = credit received (categorical) and x_9 = training received (categorical).

Besides, to determine the percentage likelihood of women's participation, the marginal effects of independent variables were calculated. As the probability of off-farming are shown;

$p(Y) = 1|X = X$, given that all other variables are constant, the marginal effects are given below with equation number 20;

$$\frac{dp(Y_i = 1|X_i)}{dx_i} = \frac{dE(Y_i|X_i)}{dX_i} = \varnothing(X'_i\beta) \tag{20}$$

3. Results and discussion

3.1. Socioeconomics characteristics of the rural women

To get an insight into the differences in the socioeconomic status of women who engage in farm and off-farm activities, a descriptive analysis of several selected socioeconomic variables was presented in Table 1. The results revealed that the average age of the farming women was about 41 years which was more than the off-farming women (36 years). The majority of them were under the age group of 30–40 years for both categories of participants. That is, off-farm women were more younger than farming women, which help them to be more active and efficient in physical work. Hasan et al. (2015) also found that the majority of farming households fall under the middle age group. The significant value of the t-statistic equal to 2.34 implies that there was a significant difference in the age categories of women's participation in the study areas. This means that rural women who are involved in off-farming activities are more active in terms of age than others.

Table 1 also shows that there is a positive but insignificant relationship of non-farm activities on educational level, number of members, work experience, credit facilities and training of rural women households. About 17.5% of off-farm women had very good housing conditions, while none of the farm women had this type of housing condition. Here, the result of the t-value (3.566) was positive and significant (at 1% level of significance) which indicated that off-farm rural women were better in housing conditions. The average income of rural women involved in farm and off-farm was BDT 66475 and BDT 88257, respectively. From the result of the t-value (2.550), it was assessed that more income comes from off-farming activities rather than farming activities. It was also clear from Table 1 that the average family income of the farm (BDT 122587) was low than the off-farm family income (BDT 154925). The result of the t value (2.037) was significant, which means that off-farm activities were a vital part of increasing household income compared to farm income. The annual average savings of farm (BDT 7890) and off-farm (BDT 4965) were asserted that farm women had higher annual savings than off-farm women. In the case of credit received, farm women were in good position than off-farm women. Training plays an important role in motivating individuals to participate in income-generating activities (Rahman, 1996). Table 1 shows that 27.5% off-farm women had high training exposure, which was about 10% higher than the farm women in the study area. Hence it is clear from the discussion that off-farm activities bring more benefits to rural women than farming.

3.2. Relationship between rural women's personal income and their household income

3.2.1. Off-farm women's personal income and their household income

The study found that off-farm women's personal income moderately positively correlated with household income. The value of adjusted R² was 0.369, which implies that the set of explanatory variables has explained 36.9% variation in the off-farm women's personal income and 63.1% was unexplained due to diversifying income activities. However, this correlation found a significant relationship between off-farm women's personal and household income. Besides, the result also showed that 94.8% of off-farm women's personal income contributed to their household's income. The results of the survey indicated that rural women were more likely to increase their family income by up to 94% through off-farm activities. In other words, household income will keep increasing as women's personal income increases. Therefore, the results indicate that women's off-farm activities establish a positive and strong relationship between women's personal income and family income.

Table 1. The present socioeconomic status of women's participation in farm and off-farm activities.

Particulars	Farming		Off-farming		t-statistics
	Frequency (%)	Mean	Frequency (%)	Mean	
Age (years)					
Young (<30)	8 (12.5)	41.08	21 (35.0)	36.48	2.34***
Middle (30–40)	27 (45.0)		23 (37.5)		
Old (>40)	25 (42.5)		16 (27.5)		
Educational status (years)					
Can't read and write	3 (5)	2.25	2 (2.5)	1.90	1.128
Can sign only	20 (32.5)		22 (37.5)		
Primary	11 (17.5)		24 (40.0)		
Secondary	18 (30)		7 (12.5)		
Higher secondary	4 (7.5)		2 (2.5)		
Graduate	4 (7.5)		3 (5.0)		
Family size (number of family members)					
Small family (1–3)	3 (5.0)	5.00	9 (15.0)	4.65	1.125
Medium family (4–6)	51 (85.0)		44 (72.5)		
Large family (above 6)	6 (10.0)		7 (12.5)		
Working experience (years)					
Low experienced (<5)	14 (22.5)	11.43	29 (47.5)	5.45	1.44
Medium experienced (6–10)	15 (25.0)		32 (52.5)		
High experienced (>10)	31 (52.5)		0		
Housing condition					
Poor	9 (15.0)	-	0	-	3.566***
Good	51 (85.0)		50 (82.5)		
Very good	0		10 (17.5)		
Personal income (BDT)					
Low income (<50 thousand)	9 (15.0)	66475	12 (20.0)	88257	2.550**
Medium income (50–90 thousand)	48 (80.0)		30 (50.0)		
High income (>90 thousand)	3 (5.0)		18 (30.0)		
Annual household income (BDT)					
Small (50<)	6 (10.0)	122587	2 (2.5)	154925	2.037**
Medium (51–100)	33 (55.0)		21 (35.0)		
Large (>100) Total	21 (35.0)		37 (62.5)		
Savings (BDT)					
Low (up to 5 thousand)	39 (65.0)	7890	42 (70.0)	4965	1.412
Medium (6–12)	14 (22.5)		12 (20.0)		
High (13>)	7 (12.5)		6 (10.0)		
Credit received (BDT)					
Low credit received (Up to 9 thousand)	21 (35.0)	27425	15 (25.0)	15885	1.053
Medium credit received (10–17 thousand)	32 (52.5)		14 (22.5)		
High credit received (>17)	7 (12.5)		31 (52.5)		
Training received (days)					
Low (up to 6 days)	18 (30.0)	10.08	41 (67.5)	19.08	1.588
Medium (7–12 days)	32 (52.5)		3 (5.0)		
High (>12 days)	10 (17.5)		16 (27.5)		

Source: Author's estimation based on field survey, 2019

Note: ***, ** and * indicate 1%, 5% and 10% significance level; Values in parenthesis indicate the percentage of different socioeconomic characteristics of women.

Unni and Rani (1999) found that women contribute more to informal economic activity and generate income and employment opportunities. Sudarshan et al. (2007) noted that the *beedi* (cigarette) workers made a significant contribution; in rural Tamil Nadu the income was recorded as 46% of the total. Senadza (2011) reports that non-farm income as a share of total household income in rural Ghana increased from 35% in 1998 to 41% in 2006.

3.2.2. Farm women's personal income and household income

Women's personal income of farms was also positively correlated with household income. In this case, adjusted R^2 (.036) implies that only 3.6% variation in farm women's income has been explained, while 96.4% was

Table 2. Impact of off-farm activities on rural women's income.

Dependent variable women's income					
Matching algorithms	Treated	Control	ATT	Bootstrap S.E	T
NNM	60	16	12949.733	4625.324	2.800***
RM	59	23	10919.271	3294.618	3.314***
KM	60	23	12638.119	3390.124	3.728***

Author's computation based on survey data: where ***p < 0.01.

Table 3. Regression results of determinants of off-farming activities.

Variable	Coefficient	Robust Std. Error
Age	0.0186912	0.0302623
Educational status	0.3339199	0.1914768*
Family size	0.2094261	0.1181781*
Work experiences	0.4256517	0.0581183***
Housing conditions	0.0181088	0.2507514
Personal income	-9.26e ⁻⁰⁶	4.00e ^{-06**}
Saving	2.334849	0.5011905***
Credit	-0.2632413	0.4751075
Training	1.216122	0.4842821**
Number of observation	120	
Wald Ch ² (9)	63.33.17	
Pro > Chi ²	0.0000	
Pseudo R ²	0.6449	
Log likelihood	-29.539668	

Note: ***, ** and * indicate 1%, 5% and 10% significance level.

Source: Author's estimation, 2019.

unexplained. In the study, there was a limited selection of farm activities; most of them were not identified due to the lack of information. They were involved in different farm activities but could not classify their participation, rate of the working hour, wage, etc. But the study found that personal income through farms had a significant relationship with their household income, but rural women's participation was decreasing due to uncertainty of production, low return, and low wage rate. They were more interested in doing work within their home adjacent areas. After maintaining the family's responsibility, it was difficult for rural women to do work in the nearest home, which was also a key point in decreasing their active participation in farm activities.

The results of this study were supported by [Hoque and Itohara \(2008\)](#), who reported that women in Bangladesh make a significant contribution to household income through agricultural and livestock production. Overall, rural off-farm women contributed 94.8% to their households, while farm women 29.4% only. On the other hand, women's farming activities established a positive but small relationship between women's personal income and family income. So, it is clear that off-farm women's income contribution to the household was higher than farm women in the study area.

3.3. Impact of off-farm income

Probit estimates of the propensity score (pscore) are presented with output from STATA software. For the matching method, a common support region was selected and the balancing property was satisfied.

The treatment effect (ATT) of off-farm activities on rural women is presented in [Table 2](#) and reports the treatment effects based on nearest neighbor, radius, and kernel matching algorithm. The results for

Table 4. Marginal effect (dy/dx).

Variable	Coefficient	Robust Std. Error
Age	0.0025466	0.0040353
Educational status	0.045496	0.0239546*
Family size	0.028534	0.0171656*
Work experiences	0.0579943	0.0050745***
Housing conditions	0.0024673	0.034219
Personal income	-1.26e ⁻⁰⁶	5.54e ^{-07**}
Saving	0.3181192	0.0491623***
Credit	-0.0358662	0.0653833
Training	0.1656946	0.0678584**

Note: ***, ** and * indicate 1%, 5% and 10% significance level.

Source: Author's estimation, 2019.

comparison of rural women who were involved in farm and off-farm livelihood activities were statistically significant and positive direction for neighbor, radius, and kernel matching estimations. The average rural women's income increases due to participation in off-farm activities were Tk. 12949.733, Tk. 10919.271, and Tk. 12638.119, and these estimates were statistically significant at the 1% levels based on the nearest neighbor, radius, and kernel matching methods, respectively. [Khan et al. \(2012\)](#) used the PSM model to evaluate the Community Based Fisheries Management (CBFM) project, indicating that the project was positive and significant for poor fishers who were involved in the co-management system. [Agbenyo et al. \(2022\)](#) showed that crop insurance had a positive and significant effect on cocoa farmers, with cocoa farmers' age having a negative effect, marital status being positive, and savings having a positive and significant effect on cocoa farmers' income. The present study has also proved that off-farm activities have a positive and significant impact on the income of rural women.

3.4. Estimation of probit model

The estimation of the binary Probit model and marginal effects of associated explanatory variables ([Tables 3 and 4](#)) revealed that six of the nine explanatory variables used for the analysis had a significant effect on engagement in off-farm. Specifically, these variables were educational status, family size, work experiences, personal income, savings, and training. Education is one of the important variables for increasing income ([Fuje, 2017](#)). As expected formal education positively influenced more participation in off-farm activities at a probability level ($p \leq 0.1$).

Working experience was one of the important factors affecting the participation of rural women in farm or off-farm activities. The working experience was statistically significant in the estimated model at a 1% level and positively related. The results of the study indicated that with the increase in working experience, the tendency of rural women to participate in off-farm activities has increased which is making them more efficient and decreasing the farm activities in the study areas. This research result has an inverse opinion to [Roy et al. \(2017\)](#). Personal income is an important factor that also contributes to upgrading women's status, which was previously disrespected ([Islam and Sultana, 2006](#)). The co-efficient of women's personal income was negative but significant. It revealed that women were more interested in off-farm activities in rural areas than on farms due to cash receipts, but women's participation at expected rates was still relatively low due to the low prevalence of work. That is, the participation of rural women in off-farm activities is still very low which needs to be opened to future possibilities. Because active participation of rural women in off-farm activities will increase their personal income which will ensure their family income and increase the standard of living. There are many opportunities for them to take up appropriate earning activities. Savings were identified as another important factor affecting women's participation in off-farm activities. It was positive and significant on the participation of women in off-farm activity at a 1% probability level. Thus, by participating in off-farm, women become more independent in saving which makes them self-reliant, able to meet family needs and participate in future investments. Through training, rural women acquire advanced knowledge and collect updated information on modified off-farm strategies that enable them to take up improved off-farm activities in the future. This result corresponds to the findings of [Hoque and Itohara \(2008\)](#).

The results of marginal effects corroborate the fact that other factors being constant, the probability of off-farm increased by 0.058 for women who were experienced to work. Moreover, inexperienced women had a barrier to productive and improved economic opportunities. The results further revealed that women's personal income had a negative but significant effect due to their participation in off-farm activities. Saving have a positive and significant effect on off-farm activities. The training is helping women find better alternative ways of earning and gaining and disseminating knowledge through access to updated information. Therefore, in addition to farm activities, off-farm activities are also very important. In a country where almost half of the population is women,

financial liberation is essential to create opportunities for their participation in the labor market, otherwise, the achievement of the overall Sustainable Development Goals (SDGs) will be hampered.

4. Conclusion

Although rural women in Bangladesh have long been involved in farm and off-farm activities, most women in north-western Bangladesh have been involved in agriculture science from ancient times. Recently, women in this area are shifting from farm to off-farm activities. However, declining agricultural land, low yields, low market prices, low wages and, above all, the rising cost of living are gradually losing interest in their agriculture. This study, therefore, analyzes how women's personal income from off-farm activities is affecting their socio-economic status, and household income, and what factors are influencing rural women's uptake of off-farm activities. Considering their socio-economic characteristics, it can be said that rural women benefited more by taking up off-farm activities than on-farm activities. It analyzed how much of their personal income was part of the family's total income and indicated that women in the research area were currently focusing more on what kind of activities were needed to earn them. The t-test showed that off-farm activities were significantly ahead for women from farm in terms of socioeconomic variables (i.e. age, housing condition, personal income, and annual household income). The study also found that women's personal income through off-farm activities contributed more to their household income than farm women by analyzing Pearson's correlation test.

Most importantly, a propensity score matching method was used to assess the impact of off-farm activities on rural women's income, indicating that off-farm activities had a positive and significant impact on women's earnings. The Probit analysis revealed that work experience, housing conditions, savings, and training were positive and significant, which helped women to give more importance to off-farm activities than farms. Rural women reported that as a result of industrialization and mechanization in farms, the overall level of training for women in harvesting, poultry, and cattle rearing has decreased but the number of women trained in off-farm work has increased day by day. However, the study did not explain how much industrialization or mechanization reduced women's participation in farm activities. It has also not been possible to analyze the extent to which off-farm activities may contribute to the poverty status of selected households and poverty alleviation, which were a major limitation of this study. However, future researchers can be expected to work on these issues later. The rapid expansion of women's education needs to be encouraged to expand off-farm wage-employment opportunities in rural areas with an expanded network of export-oriented production. Off-farm earning women are not skilled, so it is necessary to provide skill development training in off-farm to engage themselves at this time in the vicinity of the rural towns, hats, and Bazar. The provision of training also needs to synchronize with the seasonality of off-farm operations and the marketing of off-farm products and services. Therefore, government and non-government organizations need to take necessary steps for the effective and efficient participation of women in off-farm activities. We need to create a women-friendly environment for the effective participation of rural women outside the home. If effective strategies are followed, rural women will also play a key role in driving GDP growth, leading the country towards achieving the Sustainable Development Goals (SDGs) by 2030.

Declarations

Author contribution statement

Md. Soriful Islam: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Shamima Islam: Analyzed and interpreted the data; Wrote the paper.

Kanj Fatema: Contributed reagents, materials, analysis tools or data.

Romaza Khanum: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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