ISSN No:-2456-2165

Livelihood Improvement of Rural People through Solar Home System - A Case Study of Renewable Energy Development in Remote off Grid and Char Areas in Bangladesh Project

Md. Monarul Islam
Joint Director, Dept. of Policy and Planning
PDBF, Dhaka-1216, Bangladesh

Abu Sayed Md. Kamruzzaman
Joint Secretary, General Economics Division
Planning Commission, Bangladesh

Mohammad Rafiqul Islam
Sr. Assistant Director, Policy and Planning, PDBF, Dhaka-1216, Bangladesh & PhD Student of SAU, Dhaka-1207, Bangladesh

Mohshi-U-Nahidy Islam
Internship Student, Dept. of Apparel Manufacturing, NITER, Dhaka, Bangladesh

Md. Shafiqul Islam
Joint Director, Dept. of Field Operation
PDBF, Dhaka-1216, Bangladesh & PhD Student of SAU
Dhaka-1207, Bangladesh

Abstract:- Sun oriented Energy is an extraordinary hotspot for tackling power emergency in Bangladesh. The fundamental reason for this research was to decide the livelihood improvement of the beneficiaries through solar home system (SHS) at Gangachara upazila of Rangpur district and Hatibandha upazila of Lalmonirhat district under Renewable Energy Development in Remote off Grid and Char Areas in Bangladesh Project. A poll based overview strategy was utilized to gather essential information from the time of September 2020 to October 2020. A sum of 9280 PDBF beneficiaries of Gangachara upazila utilizing SHS were comprised the number of population of the study. The sample size of this research work was 369. A reserve list of 37 (about 10 % of the sample) was prepared for this study. All charts and diagrams were prepared using the software such as MS Excel and Statistical Package for the Social Sciences (SPSS) was used to analyze the data. The study found that solar electrification provided direct and indirect improvement of livelihood to the users of the system, with many implications of a permanent nature. A correlation coefficient between the livelihood improvement by using of Solar Home System (SHS) with occupation, receiving training and problem faced (-.137, .744 and -.259 respectively) were significantly correlated (P<0.01). It brought about less contamination, greater light and more long stretches of light at night, just as less work for cleaning lamp fuel lights. Sun oriented force give to the general solace and fulfillment of the consumer. Government and the private sector should take more initiatives to disseminate SHSs and develop infrastructure to solve our power crisis problem.

Keywords:- *Livelihood Improvement; Solar Home System; Rural People.*

I. INTRODUCTION

Sunlight based power assumes a crucial job in building up the economy and the way of life of a nation. To improve work openings, approaches and inspirations are there to support the advancement of both the rural and industrial areas which are totally depends upon power. In Bangladesh, a reasonable part of the population actually doesn't have the admittance to power. “Only about 60% of total populations in Bangladesh have access to electricity and it would take around 15 years to provide electricity to all” [17].

Individuals have an enormous unsatisfied interest of energy, which is developing by 10% yearly. There are many chars and remote areas in Bangladesh where electricity facilities have not reached. They have to do all the work with wood fuel, hurricanes and candles. Where, they have no choice but to provide oil for the hurricane. They need to take alternative measures of electricity. Although there are many types of energy sources, the utilization of sun based energy is the most convenient and its production process is much easier and more efficient. The utilization of sun powered is most viable in Bangladesh. “Daily solar radiation is 4-6.5 kWh/m² and maximum radiation is generally received in the months of March-April and minimum in December-January. Hence, solar energy can be a viable solution for the power crisis in Bangladesh” [8]. Sun based Energy is an extraordinary hotspot for tackling power emergency in Bangladesh. Bangladesh is a south Asian nation situated in the middle of scopes 20°34' and 26°39' north and longitudes 80°00' and 90°41' east. In this way, it is an ideal area for sun based energy usage. Also, as it is a subtropical country, 70% of the year sunlight is plentiful [1]. Bangladesh government plan to increase the electricity production capacity is 24,000 MW by 2021 and 40,000 MW by 2030 and by the year 2020 the

ISSN No:-2456-2165

renewable energy power generation will be 10% (2000 MW) of the total power generation. Energy saving will be 15% by the year 2021 and 20% by 2030 of total energy consumption. Gangachara upazila of Rangpur district and Hatibandha upazila of Lalmonirhat district are a river flooded off-grid and chars areas and Gangachara upazila of Rangpur district also included to produce 55 MW power from renewable energy in national planning.[4].That is why Bangladesh government took up a project with the help of Palli Daridro Bimochon Foundation (PDBF) at these most vulnerable areas named "Renewable Energy Development in Remote off Grid and Char Areas in Bangladesh" from March 2018 to June 2020. The goal of this study is to decide the improvement of livelihood that has come from the utilization of SHS in that project areas.

II. MATERIALS AND METHODS

This examination was done during the time of 01 September 2020 to 31October, 2020 at Gangachara upazila of Rangpur district and Hatibandha upazila of Lalmonirhat district in Bangladesh. A total of 9280 PDBF beneficiaries using SHS were constituted the population of the study. For finite population, the sample size was calculated by using the statistical formula [12]: $n= (z^2.pq.N)/\{(e^2 (N-1)+z^2.pq\}$.....(i). Thus the sample size of this study was 369. A reserve list of 37 (about 10 % of the sample) was prepared for this study. 8 selected characteristics such as age, education, family member, occupation, land position, training, down payment and problem faced were the independent variable of this study. Where, Livelihood improvement by using of SHS was the dependent variable of this study. An interview schedule containing direct questions and some scales were used for data collection from the selected respondents under project beneficiaries. Data was collected from the respondents by face to face interviewing by the PDBF staffs of Gangachara and Hatibandha upazila. Excel and Statistical Package for the Social Sciences (SPSS) was utilized to examine the information. Inferential (correlation,) and descriptive (e.g. range, observed range, mean, standard deviation and coefficient of variation) statistics were used to determine the research results.

III. SOLAR HOME SYSTEM

- *Potential of Solar Energy in Bangladesh (As environmental aspect)*

Bangladesh is arranged somewhere in the range of 20.30 and 26.38 degrees north scope and 88.04 and 92.44 degrees east which is an ideal area for sun oriented energy usage [4]. On an average of 5 kWh/m2 sun based radiation falls on this land more than 300 days for each annum. Greatest measure of radiation is accessible on the period of March-April and least on December-January. A recent report found the day by day daylight hours in Bangladesh to go from 10 to 7 hours; they further diminished this by 54% (to 4.6 hours) to represent precipitation, cloud, and mist [7, 10].

- *Typical solar home system*

According to Fig. 1. The SHS is a fixed establishment intended for homegrown application. The sun oriented module is introduced and presented to daylight, for the most part on the highest point of rooftop. A basic Solar Home System (SHS) comprises of solar generator (PV module), lead battery, and charge controller, as well as the directly connected DC appliances. Likewise, a help structure for the module, links, and attachments for the SHS is required. For example, SHS can supply electrical force required for lighting, TV, radio, or for a little fridge.

Figure 1: Typical solar home systems configuration diagram, Source: [9]

Photovoltaic (shortened PV) is the most immediate approach to change over sun powered radiation into power and depends on the photovoltaic impact, both the module measure and the sunshine openness choose the proportion of intensity available for step by step use. PV panels can be mounted on existing structures, (for example, housetops) to have decentralized electricity. The PV system are powered by sun oriented energy, sunlight based cells convert sun based energy into power. The power is put away in batteries and solid force can be available around evening time and on dull days [14].

- *Future plans and Target (Renewable Energy) of Bangladesh*

Bangladesh government plan to increase the power generation capacity is 24,000 MW by 2021 and 40,000 MW by 2030 and by the year 2020 the renewable energy power generation will be 10% (2000 MW) of the total power generation. Energy saving will be 15% by the year 2021 and 20% by 2030 of total energy consumption. Activities have been taken to deliver 30 MW power from environmentally friendly power from Dhaka, 60 MW from Rangunia, 3MW from Sarishabari, 55 MW from Gangachara, 200 MW from Mymensingh, 20 MW from Cox's Bazar and 200 MW from Sun Edition Solar project at Teknaf. To meet this objective, government has arranged a year-wise arrangement, which is somewhat upper reach from the approach target. The year-wise achievement plan of renewable energy in Bangladesh has been shown in the table 1 [6].

Table no 1: Renewable Energy Year-wise targeted plan in Bangladesh.

Technology	Achievement up to 2016 (MW)	2017 (MW)	2018 (MW)	2019 (MW)	2020 (MW)	2021 (MW)	Total (MW)
Solar	200	120	350	250	300	250	1470
Wind	2.9	50	150	350	300	300	1153
Biomas	0	6	6	6	6	6	30
Biogas	5	0	0.5	0.5	0.5	0.5	7
Hydro	230	-	1	1	2	2	236
Total	**437.9**	**176**	**507.5**	**607.5**	**608.5**	**558.5**	**2896**

Bangladesh state-claimed foundation improvement organization restricted (IDCOL) have just introduced 3 million sun powered home frameworks (SHS) by giving clean energy more than 13 million of the provincial populace. Bangladesh gets a normal every day sun oriented radiation in the scope of 4-5 kWh/m [16]. Anyway the complete creation of sun based energy in Bangladesh is 650.06 MW [6].

➢ *Daily and monthly power generation at project areas*

Absolute 9280 Solar Home Systems (SHSs) were dispersed to the PDBF beneficiaries at project zone. So to discover the everyday energy age we need to duplicate this number to day by day average daylight length. Again for finding the month to month energy age we need to increase day by day energy age to number of days of every month separately. Using average 5 hours of full sun, gives us this equation-**65 watts** x **5 hours** x **75%,** that's 0.244 kW (244 watts) in a day per 65-watt panel. If we multiply 0.244 kW per panel by 30 days in a month, we will find that each 65 watt rated panel will produce about 7.32 kW in an average month [4]. Table no 2 is shown the daily and monthly average electricity generations in KWh provided panels by the "Renewable Energy Development in Remote off Grid and Char Areas in Bangladesh" named project.

Table no 2: Calculation of daily and monthly average solar power generation in KWh at project area

Parameter	Daily energy generation (kWh)	Monthly energy generation (kWh)
Power Generation (KW)/Panel	0.244 kW	7.32 kW
Power Generation (KW)/Total 9280 Panels of SHS Project	2264.32 kW	67929.60 kW

IV. RESULT AND DISCUSSION

Possible range, observed range, mean, standard deviation (SD), co-efficient of variation (CV%) of 8 selected characteristics (age, education, family size, land position, training, down payment, problem faced, benefit derived) of the SHS using beneficiaries in the present study have been presented in Table no 3. The mean value of age, education, family size and land position of the beneficiaries were 41.48, 8.74, 5.07 and 56.69 respectively.

Table no 3: Possible range, Observed range, Mean, Standard deviation, Coefficient of variation of the selected characteristics of the respondent beneficiaries

Selected characteristics	Unit	Possible Range	Observed range	Mean	Std. Deviation	CV (%)
Age	No. of years	-	22-80	41.45	11.56	27.89
Education	Schooling years	-	1-13	8.48	2.53	29.83
Family Size	No. of person	-	3-10	5.07	1.38	27.22
Land Position	Decimal	-	3-222	57.61	58.95	102.33
Training	Score	0-15	0-15	12.39	2.067	16.68
Down Payment	Score	0-18	13-17	15.04	1.102	7.33
Problem Faced	Score	0-15	1-8	3.78	1.839	48.65
Livelihood Improvement	Score	0-21	0-21	18.73	2.031	10.84

Data contained in Table 4 indicate that around three fourth (72.6 percent) of the beneficiaries were middle aged compared to 19.5 percent being old aged and only 7.9 percent in young aged category. Findings indicate that most (92.1 percent) of the beneficiaries were middle and old aged. These categories of beneficiaries and their families were more interested to use Solar Home System (SHS).

Table no 4: Distribution of the SHS beneficiaries according to their age

Categories (years)	SHS Beneficiaries		Mean	Standard deviation	CV%
	Frequency	Per cent			
Young (≤35)	29	7.9	41.45	11.56	27.89
Middle Aged (36-50)	268	72.6			
Old (>50)	72	19.5			
Total	369	100.0			

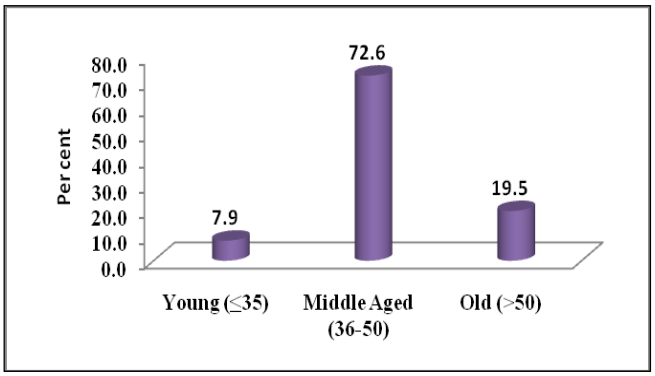

Figure 2: Distribution of the SHS beneficiaries according to their age

According to the level of educational qualification, the categories and distribution of the respondents were shown in Table no 5. Data indicated that near about half (44 per cent) of the respondent's educational qualification were above secondary, compared to secondary (32 per cent) and primary education level (24 per cent). From this we understand that the education rate in the research area is not worse than other areas of the country. Harun (2015) additionally found that rural electrification policies, programmes and plans integrate SHS as an alternative source for the supply of electricity services for remote rural communities. As a result, children will get access to lighting in the evening to extend their studies. [5]

Table 5: Distribution of the SHS beneficiaries according to their educational qualification

Categories	SHS Beneficiaries		Mean	Standard deviation	CV%
	Frequency	Percent			
Primary education (≤5)	87	24	8.48	2.53	29.83
Secondary education (6-10)	119	32			
Above secondary education (>10)	163	44			
Total	369	100			

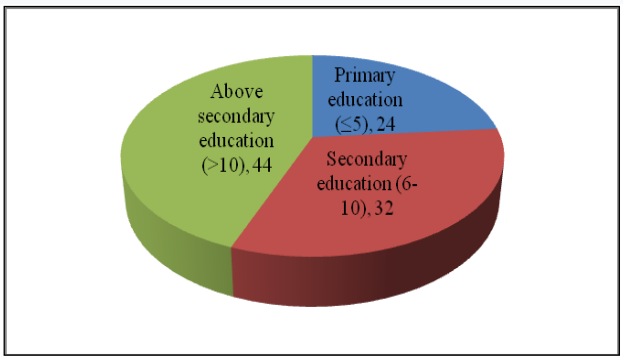

Figure 3: Distribution of the SHS beneficiaries according to their educational qualification

Information introduced in the Table 6 demonstrated that close about half (44.4 percent) of the SHS beneficiaries were medium family and contrasted with 39.3 percent being little family and just 16.3 percent in large family. Results of the study shows that most (83.7 percent) of the beneficiaries were including medium and small family. This may be due to the power supply capacity of Solar Home System (65 watts) panel through the project.

Table no: 6 Distribution of the SHS beneficiaries according to their family size

Categories (No. of person)	SHS Beneficiaries		Mean	Standard deviation	CV%
	Frequency	Per cent			
Small family (≤4)	145	39.3	5.07	1.38	27.22
Medium family (5-6)	164	44.4			
Large family (>6)	60	16.3			
Total	369	100.0			

ISSN No:-2456-2165

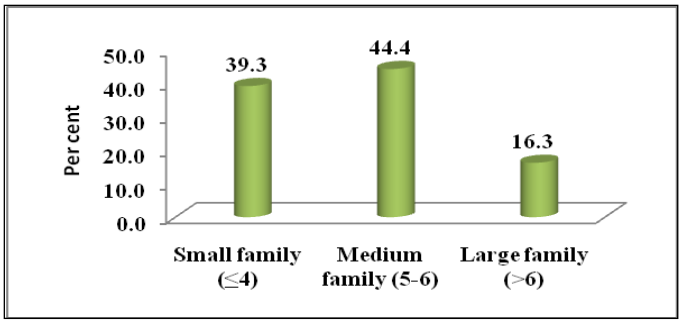

Figure 4: Distribution of the SHS beneficiaries according to their family size

As shown in Table 7, the highest occupations among SHS beneficiaries were agriculture (32.8 per cent) and small business (29.5 per cent). More than half of all SHS beneficiaries' occupations were agricultural and small business types (62.3 per cent). In the study areas, among SHS beneficiaries' occupations a considerable percentage was in service (19.8 per cent) and others occupations was 17.9 per cent.

Table no: 7 Distribution of the SHS beneficiaries according to their occupation

Categories	SHS Beneficiaries		Mean	Standard deviation	CV%
	Frequency	Per cent			
Agriculture	121	32.8	2.23	1.09	48.97
Small Business	109	29.5			
Service	73	19.8			
Others	66	17.9			
Total	369	100.0			

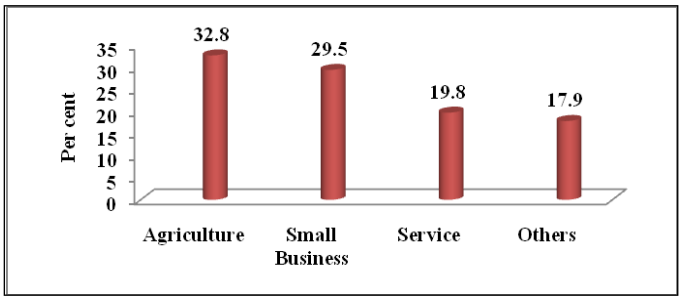

Figure 5: Distribution of the SHS beneficiaries according to their occupation

Data presented in the Table 8 showed that slightly more than one third (36.9 per cent) of the SHS beneficiaries were landless beneficiaries where slightly less than one third (29.5 per cent) of the SHS beneficiaries were medium farm beneficiaries. Small proportions slightly higher than one fifth (21.7 per cent) of the SHS beneficiaries were marginal farm size. Very small proportions (11.9 per cent) of them were found as small farm size. Findings revealed that occupations of the SHS used beneficiaries were more or less nearby same proportion.

Table no: 8 Distribution of the SHS beneficiaries according to their land position

Categories (decimal)	SHS Beneficiaries		Mean	Standard deviation	CV%
	Frequency	Per cent			
Land less (≤20)	136	36.9	57.61	58.95	102.33
Marginal (21-50)	80	21.7			
Small (51-100)	44	11.9			
Medium (>100)	109	29.5			
Total	369	100.0			

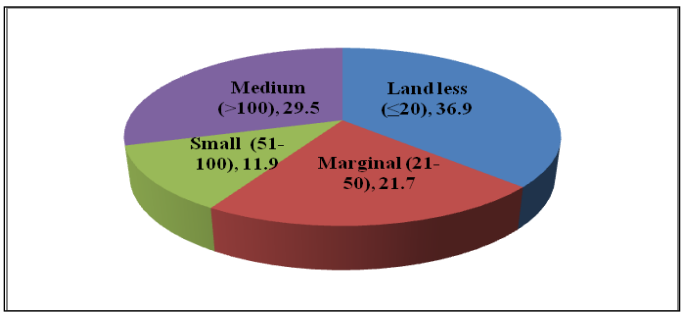

Figure 6: Distribution of the SHS beneficiaries according to their land position

A correlation coefficient between livelihood improvement and selected characteristics of the SHSs using beneficiaries is calculated and presented in the table 9. Occupation, receiving training, problem faced (-0.137, 0.744 and -.259 respectively) were significantly correlated (P<0.01) with livelihood improvement by using of SHS. These results are tantamount with the positive financial improvement of SHS recipients and it likewise uncovered that sun based lights have been thoroughly looked into as for the exhibition of youngsters going to essential and auxiliary schools in a

topographically topographical disoriented territory in northern Bangladesh [10, 11].

Table no 9: Relationship between selected characteristics of the beneficiaries and their livelihood improvement through using Solar Home System (SHS)

Selected characteristics	Correlation co-efficient (r)
Age	-0.057 (NS)
Education	-0.083 (NS)
Family size	0.027 (NS)
Occupation	-0.137**
Land position	0.052 (NS)
Receiving training	0.744**
Down payment	0.072 (NS)
Problem faced	-0.259**

NS= Not significant
** = Significant at 1% level

V. CONCLUSION AND RECOMMENDATION

Sun based Home System (SHS) is the achievable type of environmentally friendly power in Bangladesh. It has extensive affect the lives of the regional individuals in Bangladesh by furnishing them with various immediate and roundabout financial advantages. The use of SHSs improve the life quality, reduce the hazards effects of pollution, ensure uninterrupted electricity supply and also increase the reading hours and working hours of students and workers in night respectively. That is why; government and the private sector should take significant effort and target to establish different projects on renewable energy to solve our power crisis problem.

ACKNOWLEDGEMENT

The authors are grateful to Dept. of Agricultural Extension & Information System, SAU and Palli Daridro Bimochon Foundation (PDBF) staffs those whom were engaged with the field-level information assortment and furthermore obliged to SHS beneficiaries at Gangachara and Hatibandha upazila for their accommodating coordination..

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