Protibesh
Volume 17, Issue 1, January 2019
PP. 35 - 44

Dwelling Unit Prototypes for Rural Bangladesh for Greater Adaptability to Changing Socioeconomic and Environmental Needs

Mujtaba Ahsan[1], Md. Nafizur Rahman[2], Shahriar Iqbal Raj[3] and Maruf Hossain[4]

Almost eighty one percent (81%) of the housing stock in Bangladesh is in the rural areas, of which sixty nine percent (69%) are of informal sector construction. Because of its geographical location, the traditional housing stocks are vulnerable to periodic flooding, cyclone, and other natural disasters, including riverbank erosion. These houses built with organic materials and metal sheets are vulnerable to natural disasters and agents of decay. Comparatively resilient housing stock for the large rural population is a precondition to the growth and improvement of the socio-economic conditions of the people. With the introduction of Modern lifestyle amenities (television, radio, electric lighting and mobile telephone) in the rural areas, the demand for electricity has risen for which neither the informal energy technologies on which these households have traditionally relied upon, nor the rural energy supply from the national grid appeared to be adequate. The health and sanitation conditions of the traditional homesteads, in many cases, are inadequate and have scope for improvement. This study was undertaken under a Housing and Building Research Institute (HBRI) project where six (6) dwelling prototypes were developed to address these challenges with the objective that these prototypes could be replicated in the rural settings on a larger scale. Of the six (6) units designed, four(4) are discussed in this paper. The general improvements proposed in these prototypes were divided into three categories – constructional improvement for better resilience, supplementary energy technologies to meet growing energy demand and improved health and sanitation of the occupants.

Keywords: *Eco-Housing, Rural house, Sustainability, Energy, Health and Sanitation*

INTRODUCTION

According to the Bangladesh government's household income and expenditure survey (BBS, 2016. p.xiii), eighty nine percent (89%) of the total housing stock in the country are semi-permanent and non-permanent of which eighty nine percent (72%) follow indigenous construction methods. The vulnerability of the housing stock to seasonal flooding, waterlogging, cyclone, high tide, and riverbank erosion are common and recurring features. However, in spite of being the shelter for the majority, issues such as how to improve durability, health and hygiene practices and obtain better energy management options for this housing stock in the rural areas are only partially addressed by established codes and by-laws. The National Housing Policy has reduced the role of the government as the facilitator and enabler of shelter for the marginalised population and disadvantaged women only (Islam, 2014); and the Bangladesh National Building Code primarily addresses development in the urban areas. While the government has limited resources to resolve the issue, top-down intervention in rural housing has enjoyed foreign support, mainly since the massive flooding and cyclone led disasters in the early 1970s (Hodgson, 1995; Paul, 2003). These were in the form of provisions of building materials, such as corrugated Iron sheet with which disaster-affected families could rebuild their

[1] Associate Professor, North South University; Bangladesh; mujtaba.ahsan@northsouth.edu
[2] Senior Research Architect, Housing and Building Research Institute (HBRI); Bangladesh; nafizhbri@gmail.com
[3] Assistant Professor, North South University; Bangladesh; shahriar.raj@northsouth.edu
[4] Assistant Professor, North South University; Bangladesh; maruf.hossain@northsouth.edu

houses, or supply of modular housing units that could be replicated and customised by the users with local craftsmen (Hodgson, 1995). Since the 1990s rural housing intervention schemes have expanded to include homestead reconstruction and socio-economic rehabilitation activities for the disadvantaged and marginaliszed rural communities which included projects such as the 'Cluster village' to rehabilitate cyclone-affected people in the coastal areas; the 'Ideal Village' project in which titles were given on land and housing to low-income people; the 'Shelter' project, and housing fund through NGOs to provide housing for the rural poor and the 'Return to Village Project' to rehabilitate urban slum dwellers evicted by the government (Khanam, 2004). The UNDP, through the lending agency, the Grameen Bank, has implemented several rural house improvement projects and financing schemes, notable amongst them is the Grameen Bank housing program to build resilient housing in flood-prone areas. Here the program, in particular, assisted the marginalised rural women (Norton, 1989). The government, with financial support from international lending agencies, has executed several rural housing improvement projects through its Local Government Engineering Department (LGED) and the Housing and Building Research Institute (HBRI). This paper describes the Eco Housing project, in particular, that was developed at the HBRI to add low technology enhancements to traditional rural dwellings in Bangladesh. Small scale alternative energy and health technologies were also incorporated that could be adopted by rural households quite easily with the existing workforce. It was assumed that the skills required to bring about these low technology adaptations could be mastered by local craftsmen.

RURAL DWELLINGS OF BANGLADESH

Traditional rural houses in Bangladesh vary in their typologies due to the needs of the inhabitants, their socio-economic conditions, cultural development, and the geographical locations at which they are situated. The income, status, size of the family, and cultural practices determine the size, design, and durability of the houses. The basic unit – the room, is rectangular, and a number of them are arranged around an internal courtyard (Haq, 1994). An adjoining pond is an integral part of the household in the villages - a natural feature arising out of the functional needs and the building process – the soil excavated being used to raise the plinth to protect the superstructure from flooding and waterlogging. The predominant building materials are bamboo, thatch, straw, jute stick, *Golpata* (*Nypa fruiticans*) and clay (Hasan, Ullah and Gomes, 2000).

Mud walled structures are more significant in number in the drier parts of the country in the northwest, especially in the regions around Rajshahi. These range from elaborate double storied buildings to single-storied earthen structures. In the southern parts of the country, particularly in the Jessore and Khulna regions, the mud houses are primarily single-storied. In some areas, houses are made with mud blocks mixed with rice husk. The wall thickness typically varies from ten to twenty four inches (10"-24"). Thatch, clay tile, and corrugated-iron sheet roofing are generally used (Chowdhury, 1995). Landmass above flood level, relatively less rainfall, and the availability of lateritic soil are considered to be the primary reasons for using these materials for house building (Hasan, Ullah and Gomes, 2000).

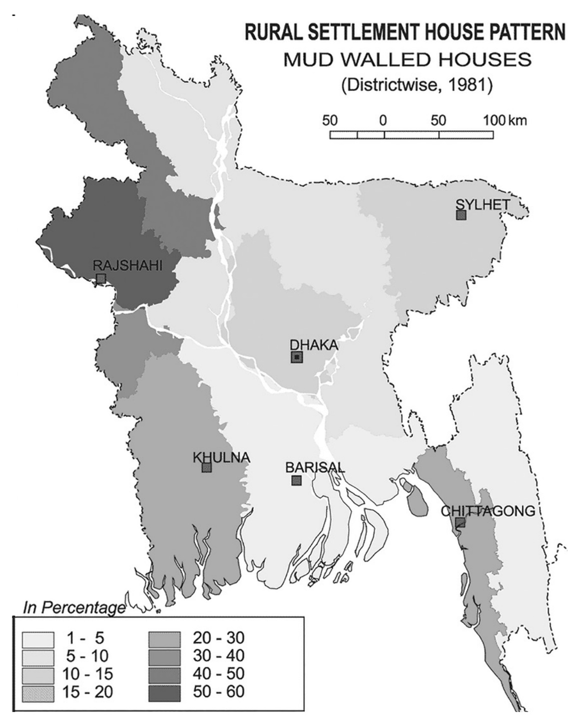

Figure 01: Area wise prevalence of mud houses in Bangladesh (Chowdhury, 1995)

Bamboo structures are the second most widely used material for house construction in the country, and they are most prevalent in the northwestern and southeastern regions. Other than tribal homes raised on bamboo or wooden stilts, the general population in these regions typically build on a mud plinth with thatched bamboo mat walls and large overhanging thatch roof of straw on bamboo framing. Tribal houses in the hilly districts on the south-east are made entirely with bamboo on a raised platform to keep away wild animals and to protect the house from flash flooding and small scale landslides.

Houses made with corrugated galvanized iron (CGI) sheet are becoming widely popular. The easy availability, durability, ease of transportation and flexibility in construction with CGI sheets, as well as, financial loan provided by local NGOs are all contributing to transforming indigenous housing stock to CGI-built structures. Corrugated iron sheet houses today symbolise a higher socioeconomic status in rural areas. Variations in the design, size, and height of the houses built with CGI sheet all correspond to the relative social status and wealth of a family in the area. Roofs with four folds of CGI sheets - *chouchala* and with two folds - *dochala*, are the two significant variations in the design. In the northeastern Sylhet region, which experiences heavy rainfall in the country, and in the central and southern areas of the country: Faridpur, Madaripur, Barisal, Patuakhali and Bhola houses made out of CGI sheets are very common. In the central part of the country, particularly in the districts of Dhaka, Comilla and Mymensingh CGI roofs are used over mud or mud block walls (Chowdhury, 1995; Hasan, Ullah and Gomes, 2000).

Other indigenous house typologies include structures made with timber by the more affluent tribal communities in the Chattogram district; and very low-cost reed, long grass, thatch, and jute stick houses built by the economically marginalised population.

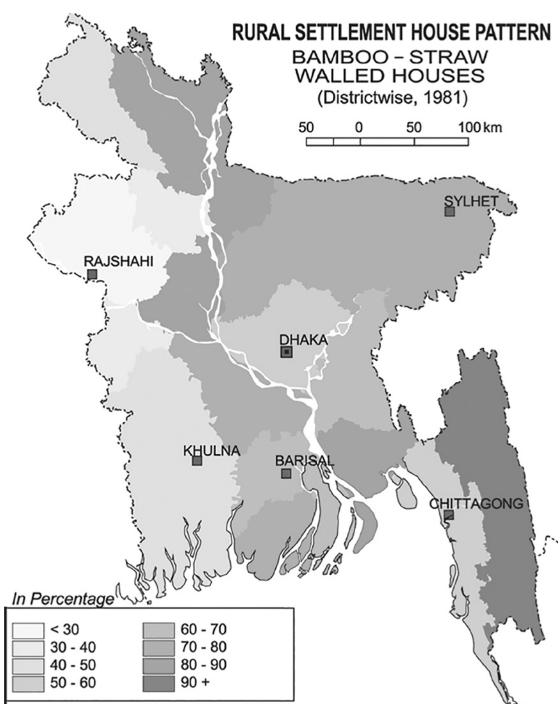

Figure 02: Area wise prevalence of bamboo houses in Bangladesh (Chowdhury, 1995)

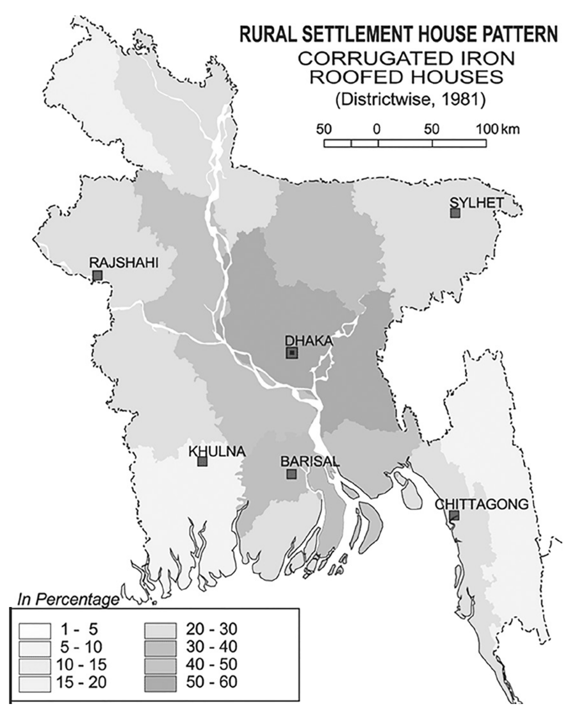

Figure 03: Area wise prevalence of CGI Sheet Houses in Bangladesh (Chowdhury, 1995)

CAUSES OF VULNERABILITY

Traditional houses in Bangladesh are generally vulnerable to climatic hazards. Among these, forty eight percent (48%) of the dwellings are directly affected by flood and waterlogging (BBS, 2015) (see fig.4). Ahmed (2005, p.3) identifies two distinct effects of flooding on structures. These include uplifting of dwelling structures due to weak anchoring in the soil at times of waterlogging, and horizontal pressure applied to structures by flood waves or flood currents. Indirect effects of flooding may include forces such as high winds or storm, lightning, slope instability, ground settlement, etc.. that can destabilise the dwelling structure. Thunder and hailstorm related damages to dwelling units are the second highest (26.82%) followed by high winds during cyclone (21.3%). In both cases, weak anchoring to the structural base is a common cause, often weakened by rotting or decay of structural members. In sustained flooding, floodwater may submerge buildings and cause various degrees of damage from staining of walls, the decay of lower parts of organic materials, to overall structural collapse.

The mud floor and plinth of houses may settle and in a prolonged flood or waterlogging, cause these to become muddy. Prolonged or recurring flood tend to rot the base of the bamboo or timber posts in moisture ridden soil of the plinth. Rotting of the base weakens the entire structure making it vulnerable to strong winds, or lead to differential settlement and sagging of roofing elements. Doors, windows, and wall elements may develop cracks and lose alignment (Ahmed, 2005). Organic jute stick and catkin grass walls that are exposed to moisture have a lifespan of only two (2) to three (3) years and bamboo mat walls of four (4) to five (5) years (Ahmed, 2005). On the other hand, galvanised corrugated Iron (GCI) sheet on timber framing corrodes due to contact with water that gets aggravated in flood. Houses that are not built higher than the local flood level experience greater structural vulnerability due to corrosion of metal structures.

The roofs of the low-end houses are typically made with catkin grass, rice, wheat or maize straw on bamboo and sometimes reed stalk framing. Usually, these have to be renewed every two (2) to three (3) years (Ahmed, 2005). These are damaged when they come into contact with floodwater or get washed off in heavy driving rain. In addition to corrosion in the damp atmosphere, roofs made with CGI sheet may be blown off or crumpled by cyclones and strong wind (Lewis and Chisholm, 1999). Most cyclone related damages to structures are caused by strong wind and accompanying storm surge. Permanent construction and superstructure firmly embedded within the plinth show better signs of survival (Lewis and Chisholm, 1999). Riverbank erosion is another common hazard in Bangladesh (BBS, 2015). Hodgson (1995, p. 160), proposes dismantle-able structures for these areas that are prone to riverbank erosion, however, such flexibility is difficult to achieve with mud houses, as well as, with the other traditional dwelling materials that are typically used in Bangladesh.

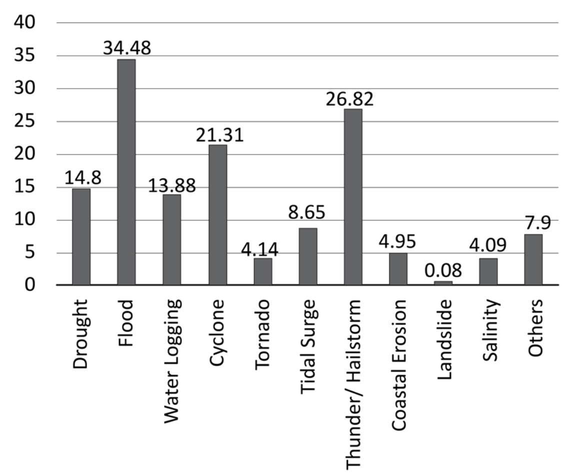

Figure 04: Primary causes of vulnerability of dwelling units by percentage (BBS, 2015)

RESEARCH OBJECTIVES

The Eco-housing project was undertaken by the Housing and Building Research Institute (HBRI) in 2007-08 with the objectives to develop dwelling prototypes for rural areas of Bangladesh that would:

- be better resilient to natural disasters and natural forces of decay, therefore, be more durable
- be incorporated with alternative energy sources, to meet the changing lifestyle of the rural communities

adapting to greater use of modern electronic devices (i.e. mobile telephones, televisions, radios, etc.)

- be replicable by the local craftsmen by maintaining only small scale technological improvements and keeping within familiar construction techniques
- be able to provide better health and sanitation conditions for the occupants

PROJECT DESCRIPTION

Under the eco-housing project, six (6) dwelling units for the rural areas of Bangladesh were constructed of which four(4) dwelling units are discussed here. The units were designed around two-room houses and common space, with a separate kitchen and toilet unit.

A. STRUCTURAL IMPROVEMENTS FOR GREATER RESILIENCE

Stabilised plinth: vulnerability to natural disasters, particularly flood and moisture driven decay was addressed uniformly in all the prototypes by having a more stable plinth which would prevent water seepage and decay due to waterlogging. Brick lined plinths with compacted sand-fill were designed instead of mud plinth. These would prevent the plinth from becoming soggy and weak in prolonged flooding and waterlogging and thereby prevent moisture driven damage to the organic superstructure, as well as, provide a more stable base for anchoring.

Prototype Rural Unit 1 was developed to adapt examples of good practices from the southern regions of Bangladesh. In this unit, chemically-treated traditional bamboo mat walls and *Golpata* (*Nypa Palm*) thatch roof over the bamboo frame was used. The bamboo structure was double framed to improve strength and anchoring of the roof with the stable brick-lined plinth. Both the structural bamboo poles and bamboo mat walls were chemically treated to increase their longevity by two times. Lewis and Chisholm (1999) have shown that by replacing traditional bamboo ties and keeping the angle within thirty (30) and forty (40) degrees, roofs can be made more stable in a cyclone. This strategy has been followed in the design with metal bolt ties and double bamboo framing anchored in a brick-lined stabilised plinth. The unit proposes a more resilient structure to flood due to its non-mud based plinth, and greater resilience to a cyclone, hailstorm, and thunderstorm and decay of traditional organic building material due both to chemical treatment and the use of double anchoring and metal ties. Cyclone and storm/ tidal surge are most prevalent in Barisal, Khulna and Chattogram districts (BBS, 2015), and this prototype unit is suited to better withstand damages to dwelling units caused by these natural hazards in these districts. Traditional dwelling units in the Khulna district suffer the most from the decay of organic building materials due to salinity. *Golpata* (*Nypa Palm*) is a proven natural material that can withstand salinity and was used in the roof construction of the prototype unit.

Figure 05: Prototype rural unit 1

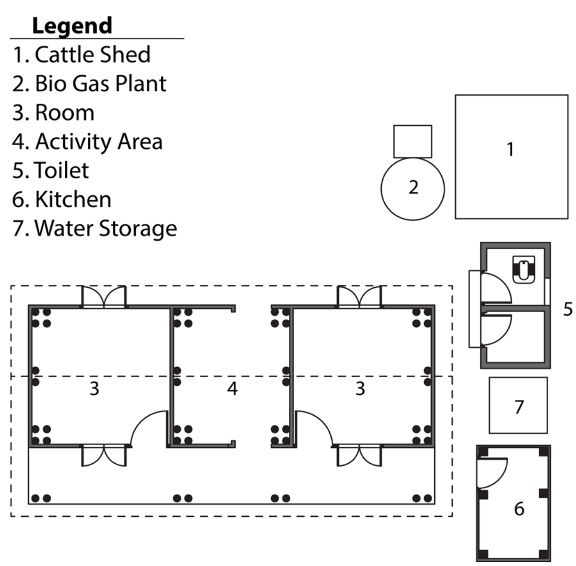

Figure 06: Layout plan of prototype rural unit 1

Table 1: Comparative analysis between rural unit 1 and traditional bamboo houses

Rural unit 1	Traditional bamboo unit
Lifetime about 10-15 years	Lifetime about 2-3 years
Golpata roof effective against moisture and salinity related decay; the angle between 30 and 40 degrees	Conventional CGI sheet roof is vulnerable under suction wind effect; less economical; leads to heat build-up indoors, corrodes in a moist environment
Double bamboo framing with metal ties provide better anchoring and greater stability	Single bamboo framing is weak in withstanding cyclonic wind

Prototype Rural Unit 2 was developed to adapt lessons learned from good practices in the northeastern regions of Bangladesh. Dwelling units in Sylhet region are seventy percent (70%) more vulnerable to flooding and moisture-laden damage, compared to similar structures in the other parts of the country because the area has the highest rainfall in Bangladesh (BBS, 2015). Therefore, in addition to the stabilised plinth, CGI roofing and *Ekraw* wall were used in the prototypical rural unit 2 to make traditional bamboo framed walls more resilient to moisture-laden decay and damage. *Ekraw* wall is a traditional technique of the Sylhet region that is both cost-effective and durable. It uses a plaster and paint coat on bamboo mat walls, thereby increases the durability of the bamboo wall significantly.

However, CGI sheets, which are widely used in the country as a roofing material because of their excellent water-resisting properties, are not recommended. The material is not eco-friendly because it becomes heated very quickly and gives rise to high levels of secondary radiation and interior heat build-up. In spite of these disadvantages, the CGI roof was used in the prototype to research on the possibilities of producing electrical energy directly from the CGI roof material. It was, however, found that the electrical energy produced per unit area of the CGI roof was not adequate to enable the operation of the essential everyday household electronic devices. The roof was supported on RCC framing on a stabilised plinth, and *Ekraw* wall was used as partitions. Styrofoam false ceiling and an air gap were provided to bring interior thermal conditions significantly close to comfort levels. It was concluded that more research work in the future is necessary to improve the electricity output from the CGI roof surface.

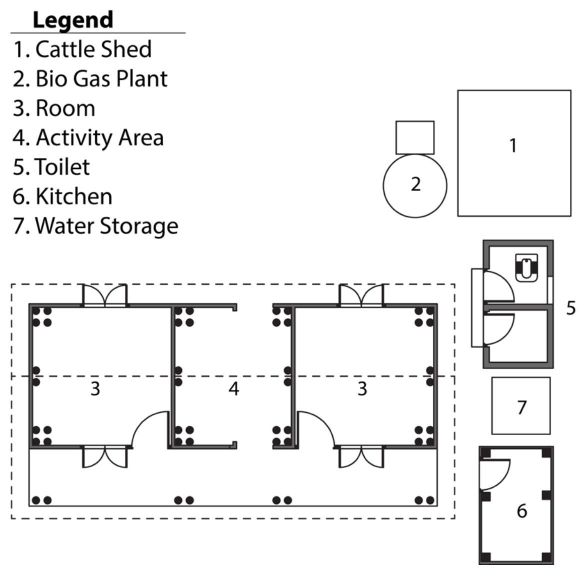

Figure 07: Prototype rural unit 2

Table 2: Comparative analysis between rural unit 2 and conventional 5” brick structure

Rural unit 2	5” Brick structure
Economical (cost Tk.52 per square foot of wall)	Comparatively expensive (cost taka 60-70 per square foot)
Durable (lifetime more than 50 years)	Durable
Space saver (thickness 2”-2.5”) Ekraw wall	Thickness 5” with brick and plaster

Prototype Units 3 and 4 were developed as intermediate alternatives between permanent brick dwellings and semi-permanent dwellings made from organic materials. These were developed by using conventional bricks and concrete blocks economically.

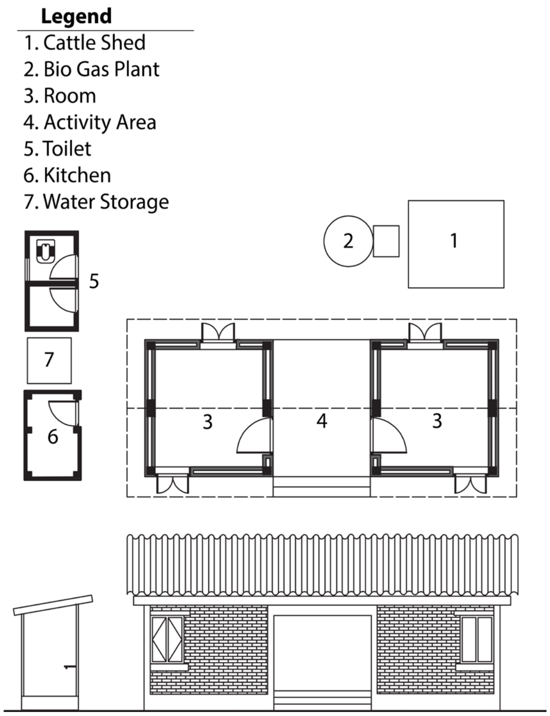

Figure 08: Prototype rural unit 3

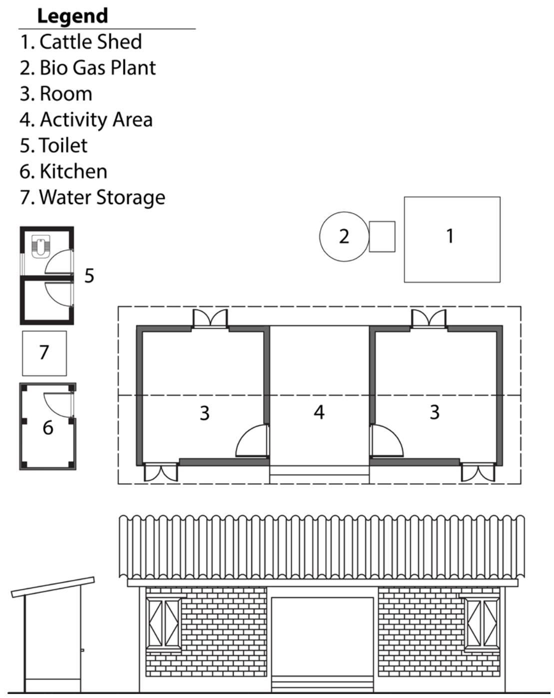

Figure 09: Prototype rural unit 4

Prototype Unit 3 was developed as a low-cost alternative to conventional practice. Rattrap bonding used for the walls. This reduced the number of bricks needed per unit volume of wall construction by thirty percent (30%), as well as, significantly improved thermal and water insulation properties. The roof was made with folded Ferro-cement plate instead of conventional RCC slab, providing cheaper and efficient roofing. This roof is better in thermal performance than that of CGI, and heavier and therefore, more stable at times of cyclone; yet cost saving as compared to typical permanent RCC construction.

Table 3: Comparative analysis between rural unit 3 and conventional 10" brick structure

Rural Unit 3	10" Brick Structure
10" rat-trap brick wall	10" solid brick wall
30% brick saving	No saving
Cost taka 100 per unit of wall	Taka 200-250 per unit
Requires less time for construction	Requires more time for construction

As indicated above, **Prototype Unit 4** was developed as an alternative to the brick structure, since brickfields are responsible for damaging croplands and contribute to environmental pollution for their use of informal energy. In this unit, hollow concrete blocks were used instead of bricks, thereby replacing the use of clay bricks. The cavity improved thermal and moisture insulation. A Ferro-cement folded plate roof made the unit more resilient to a cyclone and other natural forces of damage to dwelling units as already discussed.

Table 4: Comparative analysis between rural unit 4 and conventional 10" brick wall structure

Hollow block wall	Conventional brick
Larger size (7.5" x 17" x 4") costing Tk.25 per block, covering more area with less cost	Smaller size (9.5" x 4.5" x 2.74") costing Tk. 5 per brick for 10" price is double
Ferro cement roof costs Tk.100/sft	Conventional roof cost Tk.200-250/sft
Requires less time to construct	Requires more time to construct

B. ENERGY AND HEALTH

In addition to structural vulnerability, rural households are facing a demand for higher energy, particularly for electricity due to an increase in the use of televisions, radios, electric lighting and use of mobile telephones (BBS, 2014). Greater access to mobile phones in rural areas has created a growing demand for these technologies and support services, and thereby, on energy (Bairagi, Roy and Polin, 2011). About fifty percent (49.82%) households in the disaster-prone areas of Bangladesh have access to electrical energy for lighting, while about forty percent (39.59%) households rely on kerosene for the same (BBS, 2015). Each of the eco-housing units was, therefore, provided with forty-watt solar panels, battery and inverter to enable the operation of one black-and-white television, one LED and one fluorescent light.

Ninety-eight percent (98%) of households in the disaster-prone areas of Bangladesh rely on bamboo, wood, cow dung, dry leaves, and straw as their primary cooking fuel (BBS, 2015). Excessive smoke from cooking fuel is a health hazard while reliance on kerosene – a fossil fuel, is not sustainable. Women and children are the most vulnerable from this practice. The use of solid bio-fuel exposes them to high levels of Indoor Air Pollution (IAP) caused by smoke. Forty-six thousand (46,000) deaths per annum in the country are caused by an acute lower respiratory infection in children under-five and chronic obstructive pulmonary disease in women, by the smoke coming from cooking fuel (WHO, 2017) (GOB, 2013). In Bangladesh, the total disease burden due to IAP is estimated to be 3.6% (WHO, 2017).

Switching from smoke-producing solid biofuel to cleaner energy source is a strong requirement for rural households (Arif, Ashraf, Miller et.al., 2011; GOB, 2013). Several strategies have been proposed in the past towards using improved stoves that not only prevent IAP but can also reduce time spent by women for collecting fuel (Arif, Ashraf, Miller et al., 2011; Hossen, Saha and Mohsin, 2018). The household survey, however, indicates a preference for changing fuel type by the users. The prototype units described in this paper were, therefore, developed with an emphasis on changing the fuel type, as opposed to improving stove design. The proposal was to change fuel type from solid biofuel to biogas. Each of the dwelling units discussed was provided with a hundred (100) cubic feet (CFT) biogas plant, which would use household animal and human-generated biowaste to provide biogas for cooking.

The supply of pure drinking water is a requirement for rural households. Twenty-six percent (26%) of rural households do not have access to improved functional water sources within five hundred (500) feet of the house (BBS, UNICEF, 2017). Also, arsenic in drinking water is a health hazard in the country where only forty percent (40%) of twenty (20) million people affected have access to safe water sources (WHO, 2017). The supply of drinking water was, therefore, provisioned in the designed units by encouraging rainwater harvesting from the roof. Each unit, other than the one with the *Golpata* (*Nypa Palm*) thatch roof, was connected with a fifty two (52) CFT water storage tank to harvest rainwater.

Forty-six percent (46%) of toilets in disaster-prone areas of Bangladesh are non-permanent (kutcha) while about four percent rely on open defecation (BBS, 2015). At the national level, approximately thirty one percent (31%) of the population do not have access to improved latrine while twenty four percent (24%) of the households that use improved latrines do it on a shared basis (BDHS, 2014). Sharing related problems and insecurity at night discourage women and children from using toilets located away from their homes (Choudhury and Hossain, 2006). Suitable handwashing facilities within fifteen (15) feet of the latrine is considered an additional health requirement, which is also lacking in many cases (BDHS,2014; BBS, UNICEF, 2017). Each of the prototype housing units was, therefore, supplied with a kitchen and toilet in an adjacent location but were oriented differently from the direction of the prevailing wind.

CONCLUDING REMARKS

The eco-housing project was envisaged as low-technology enhancements to rural dwellings in Bangladesh compared to conventional practices to make them more appropriate for the economically disadvantaged groups. Rainwater harvesting and biogas plants were considered as easily manageable features that can be adopted in traditional homesteads of Bangladesh. The adoption of solar energy technology is perhaps the only area where high technical expertise is a requirement. A research effort was, therefore, made to produce electrical energy directly from conventional CGI/CI roof material instead of using costly solar panels; however, the electrical energy produced per unit area of the roof surface did not prove to be effectivel. Future research on energy technology is required to provide better alternatives in this regard.

REFERENCES

Ahmed, K. I. (2005). *Handbook on Design and Construction of Housing for Flood-prone Rural Areas of Bangladesh*. Dhaka: Asian Disaster Preparedness Center.

Arif, T., Ashraf, A., Miller, G., and et al. (2011). *Promotion of Improved Cookstove in Rural Bangladesh.* Dhaka: Research and Evaluation Division, BRAC.

Bangladesh Bureau of Statistics. (2014). *Bangladesh Population and Housing Census 2011* (Vol. 2). Dhaka: Government of the People's Republic of Bangladesh.

Bangladesh Bureau of Statistics, (2015) '*Bangladesh Disaster-Related Statistics 2015: Climate Change and Natural Disaster Perspectives*'. Dhaka: Bangladesh Bureau of Statistics (BBS).

Bangladesh Bureau of Statistics. (2016). *Preliminary Report on Household Income and Expenditure Survey 2016.* Dhaka: Bangladesh Bureau of Statistics (BBS).

BBS, UNICEF. (2017). *An Assessment on Coverage of Basic Social Services in Bangladesh*. Dhaka: Bangladesh Bureau of Statistics (BBS) and United Nations Children's Fund (UNICEF).

BDHS (2014). *Bangladesh Demographic and Health Survey.* National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International.

Bairagi, Anupam K., Roy, Tuhin and Polin, Afroza (2011). *Socio-Economic Impacts of Mobile Phone in Rural Bangladesh: A case Study in Batiaghata Thana, Khulna District.* Dhaka : International Journal of Computer and Information Technology (IJCIT), Research and Publication Unit, University of Asia Pacific. Vol. 2, Issue 1, 42-48.

Choudhury, N., and Hossain, M. A. (2006). *Exploring the Current Status of Sanitary Latrine Use in Shibpur Upazila, Narsingdi District.* Dhaka: Research and Evaluation Division, BRAC.

Chowdhury, S. I. (1995). *Arthanitik Bhugol: Visva O Bangladesh (Economic Geography: The World and Bangladesh) in Bengali.* Dhaka: Dhaka University.

GOB. (2013). *Country Action Plan for Clean Cookstoves.* Dhaka: Power Division, Ministry of Power, Energy and Mineral Resources, Government of the People's Republic of Bangladesh.

Haq, S. U. (1994). *Architecture within the fold tradition: a representation from Bangladesh.* Traditional Dwellings and Settlements Review, 5 (2), 61-72.

Hasan, M., Ullah, M. S., and Gomes, C. D. (2000). R*ural Housing in Bangladesh: an Inquiry into Housing Typology, Construction Technology, and Indigenous Practices.* In S. M. Seraj, R. L. Hodgson and K. I. Ahmed (Ed.), Village Infrastructure to Cope with the Environment, Proceedings of the Third Housing and Hazards International Conference (pp. 51-60). Dhaka: BUET and the University of Exeter.

Hodgson, R. (1995). *Housing Improvements: Disaster Response or Hazard Mitigation? Examples from Bangladesh*. Built Environment, 21 (2/3), 154-163.

Hossen, S. S., Saha, A., and Mohsin, K. F. (2018, June). *Cooking Practices in Rural Bangladesh: A Comparative Study.* International Journal of Humanities and Social Science Invention (IJHSSI), 7(07), 34-40.

Islam, M. S. (2014, November 08). *Inclusive Urban Development in Dhaka: Review of the National Housing Policy.* (M. S. Rahman, Ed.) World Town Planning Day 2014: Equality in the City: Making Cities Socially Cohesive.

Khanam, S. (2004, September 13-17). *Increasing access to housing for low-income people in Bangladesh through income and employment generation. Building Bridges with the Grassroots: Scaling up through knowledge sharing.* Barcelona, Spain: World Urban Forum UN-HABITAT.

Lewis, J., and Chisholm, M. P. (1999). *Cyclone resistant domestic construction in Bangladesh.* In R. L. Hodgson, S. M. Seraj and J. R. Choudhury (Ed.), Implementing Hazard Resistant Housing. Proceedings of the International Workshop to Explore Practical Solutions for Building Safety (pp. 28-38). Dhaka: BUET and the University of Exeter.

Norton, J. (1989). *1989 Technical Review Summary: Grameen Bank Housing Project. Aga Khan Award for Architecture.* Aga Khan Award for Architecture.

Paul, B. K. (2003). *Relief Assistance to 1998 Flood Victims: A Comparison of the Performance of the Government and NGOs.* The Geographical Journal, 169 (1), 75-89.

WHO. (2017, July 7). *Environment and Occupational Health.* Retrieved February 28, 2019, from World Health Organization Bangladesh: http://www.searo.who.int/bangladesh/areas/ environmentandoccupationalhealth/en/