ID 110 **A3-01**

Climate induced changes of precipitation extremes over Bangladesh

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ABSTRACT

Due to its geographic location and dense population, Bangladesh has been considered as one of the most vulnerable to countries considering climate change. Changes of frequency, duration and intensity of climate extremes will significantly impact human society, water resources, and ecosystems of the country. An attempt has been made to investigate possible changes of extreme events for Bangladesh considering global warming. This study quantifies changes by the results from high resolution regional climate model, PRECIS, developed by Met office, UK under moderate emission scenarios A1B for three 30-year time slices in the 21st century. It has been found that changes in daily precipitation and the precipitation extremes during monsoon (June to September) season are increasing than dry season (December to February). Under A1B scenarios, intensity of heavy precipitation and frequency of the events will be increasing while number of wet days will be decreasing towards the end of 21st century.

INTRODUCTION

Bangladesh is well known for its natural disasters such as cyclone, storm surges, floods, droughts and river erosions. Precipitation is the major meteorological variable which plays a significant role in the hydro- logical cycles as well as these extreme climatic events. Under the greenhouse warming condition, extreme daily precipitation will be increasing despite the decrease of mean precipitation. According to Wasimi, climate change has profound impact on rainfall intensity and variability [1]. Global climate models showed that global warming will increase the intensity of extreme precipitation events [2]. Alexander et al. [3] has shown that observed trends of extremes in precipitation is increasing globally and consequently the heavy precipitation indices are increasing. A recent study shows that extreme rainfall events over Central India during the summer monsoon period, 1951–2002 has significantly rising in the frequency and magnitude of extreme rain events [4]. Rajendra et al. [5] has found that increasing trends of frequency and intensity of heavy precipitation events over India using regional climate model at the end of 21st century. Considering the results of the above studies, this paper investigated changes of extreme precipitation events using the future climate change projections over Bangladesh.

MATERIALS AND METHODS

A. Study Area.

Bangladesh is located between $20^0$34'N and $26^0$33'N latitudes and $88^0$01'E and $92^0$41'E longitudes; and bounded by India in the west, north and east, Mayanmar in the southeast, and the Bay of Bengal in the south. Bangladesh is a flood plain delta of the three major rivers: the Ganges, the Brahmaputra and the Meghna which meet inside Bangladesh before discharging to the Bay of Bengal through a single outfall. Most of Bangladesh consists of extremely low and flat land with elevation ranges between 1 and 5 meters. Coastal areas in the southern parts of the country are prone to cyclonic and storm surge hazards. Drought has been found in the north- west parts of the country. Every year roughly 25% of the area has been normally flooded from the spills of three major rivers during the monsoon season. Flash floods are normally occurred in the premonsoon (MAM) seasons in the northeast parts of the country. Changes of precipitation patterns will change the intensity and frequency of these natural hazards and extreme events which can cause major catastrophes.

B. Regional Climate Model output.

PRECIS (Providing Regional Climate for Impact Studies) developed by the Hadley Centre of the UK Meteorological Office is used in this study. PRECIS was developed to generate high-resolution climate change information for as many regions of the world as possible. RCMs are full climate models and physically based. The PRECIS RCM is based on the atmospheric component of the HadCM3 climate model [6]. In this study, PRECIS model domain for South Asia has been set up to determine climate change impact over Bangladesh with a horizontal resolution of 50×50 km. This domain approximately stretched over latitudes 3.5 -36.2 N and longitudes 65.8-103.3 E and has 88×88 grid points (Fig. 1). This domain allows full development of internal mesoscale circulation and regional forcings at the regional level. The SRES A1B scenario of IPCC was used to derive the lateral boundary conditions of the simulation using three dimensional ocean-atmospheric coupled model (HadCM3Q) to generate diagnostic variables over the simulated domains over the Indian sub- continent which includes Bangladesh [7].

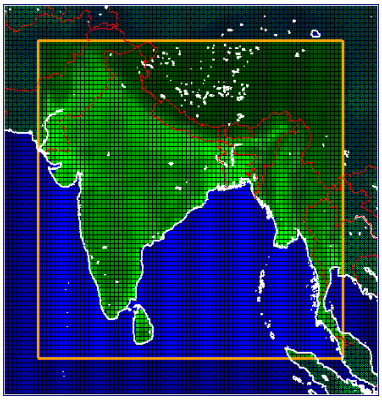

Fig. 1. PRECIS domain over south Asia

C. Extreme Indices.

The joint Expert Team (ET) on Climate Change Detection and Indices (ETCCDI) has recognized a suite of 27 core climate change indices which derived from daily precipitation and temperature data using user-friendly software package "RClimdex" (http://cccma.seos.uvic.ca/ETCCDMI/). From that list, eight extreme precipiation related indices are used in this study and shown in Table 1.

RESULTS AND DISCUSSION

PRECIS simulation was made for one baseline period 1980s (1961-90) and three future so called time-slices for 2020s (2011-2040), 2050s (2041- 2070) and 2080s (2071–2100) corresponding to IPCC-SRES A1B emission scenarios. Table 2 gives the seasonal rainfall statistics for the four time slices. During the winter season (December to February), mean precipitation will be slightly decreased for 2020s and

then again increased for 2050s and 2080s time slices. Pre-monsoon (March to May) precipitation also follows same trends as winter precipitation. However, man monsoon (June to September) and post monsoon (October to November) precipitation will constantly increase in all three future time slices. Variability of the monsoon precipitation will be much higher in future than other seasons of the year. At the end of 21st century, mean monsoon precipitation will be increased about 23% from the present condition (1980s) and variability will be increased about 70% (212mm).

The spatial patterns of changes of seasonal one day maximum precipitation, RX1 as simulated by PRECIS for the future time slices of 2050s and 2080s from the baseline period are shown in Fig. 2 and Fig. 3, respectively. During premonsoon season, precipitation will increase in the northern parts of the country than the central and south. However, during monsoon and post monsoon seasons, there will be mixed pattern of changes of seasonal one day maximum precipitation for 2050s. However, changes of one day maximum precipitation will be observed all over the country during monsoon season for 2080s. During the post monsoon season for 2080s, increase of one day maximum precipitation will be found in the northern parts and *Haor* areas of the country.

Spatial patterns of changes of days when precipitation is more than 20 mm over Bangladesh for three future time slices are shown in Fig. 3. Frequency of heavy precipitation (>20mm) shows increasing trends in future time slices in the northern parts of the country. However, these increasing trends will be observed during the monsoon season. Days of heavy precipitation will be increasing more for 2080s than for 2050s and 2020s. Heavy precipitation will be more frequent in the greater *Rangpur* areas and *Haor* areas of Bangladesh.

Probability distribution functions (PDFs) are calculated for indices of precipitation extremes for baseline, and three future time slices. Fig. 5 shows the PDFs for (1) daily intensity (SDII, mm/rainy days); (2) five-day maximum precipitation (RX5, day, mm); (3) count of days when rainfall exceeds 20mm (R20mm, days) and (4) maximum spell of continuous wet days (CWD, days) for baseline and three future time slices, respectively.

Probabilities of the intensity of precipitation, consecutive 5 day precipitation and heavy precipitation show positive trends of precipitation extremes for all three future time slices. Higher changes are found in the 2080s than 2050s and 2020s. On the other hand, probabilities of consecutive wet days will be reduced in future. The reduction of the probabilities of CWDs represents than the length of monsoon will be shorter but intensified.

Table 1: List of Indices used in the study

Index	Description	Definition
R20mm	Frequencies in days	Number of days with precipitation > 20mm
R99 p	Frequencies in mm	Extremely wet days due to heavy precipitation event exceeding 95%
R99 p	Frequencies in mm	Very wet days due to heavy precipitation event exceeding 99%
RX1day	Intensity in mm	One-day maximum precipitation
RX5day	Intensity in mm	Five-day maximum precipitation
CDD	Longest spell in days	Consecutive dry days when precipitation < 1mm
CWD	Longest spell in days	Consecutive wet days when precipitation > 1mm
SDII	Daily intensity	Simple Daily Intensity index in mm/rainy days

Table 2. Simulated seasonal and annual rainfall of Bangladesh for baseline and three future time-slices.

Years	Mean Precipitation (mm)					Standard deviations of precipitation (mm)				
	DJF	MAM	JJAS	ON	Annual	DJF	MAM	JJAS	ON	Annual
1980s	51	276	918	91	1337	35	114	131	50	141
2020s	44	229	962	112	1347	28	107	159	51	223
2050s	84	288	1012	98	1481	70	130	149	48	257
2080s	67	279	1130	125	1602	42	144	222	65	289

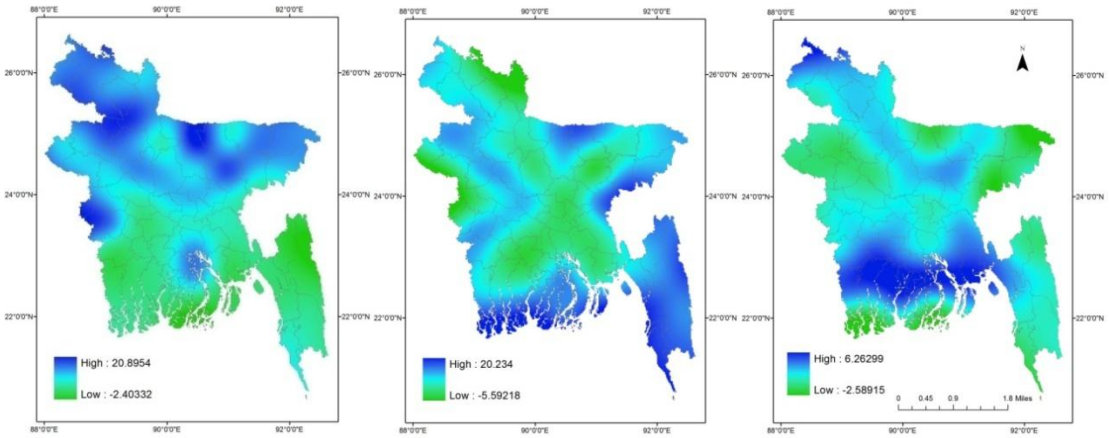

Fig. 2. Spatial pattern of changes of one day maximum precipitation (RX1) over Bangladesh during premonsoon, monsoon and post monsoon seasons for 2050s from the baseline year 1980s, respectively (from left).

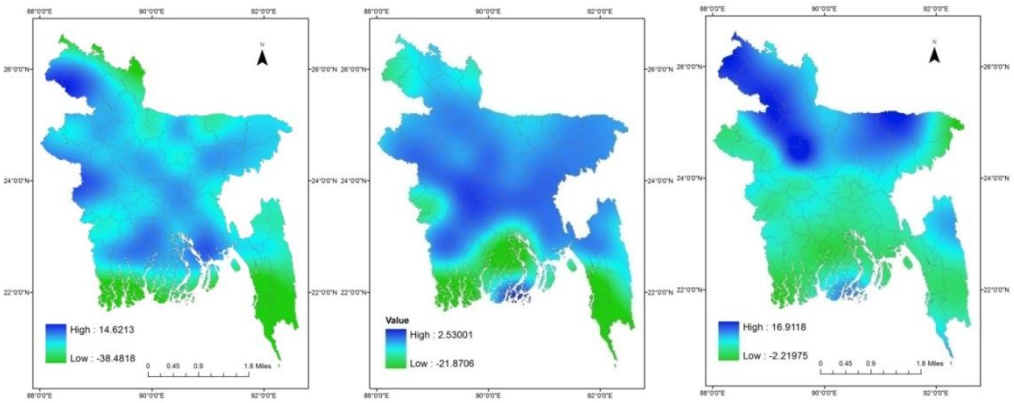

Fig. 3. Spatial pattern of changes of one day maximum precipitation (RX1) over Bangladesh during pre-monsoon, monsoon and post monsoon seasons for 2080s from the baseline year 1980s, respectively (from left).

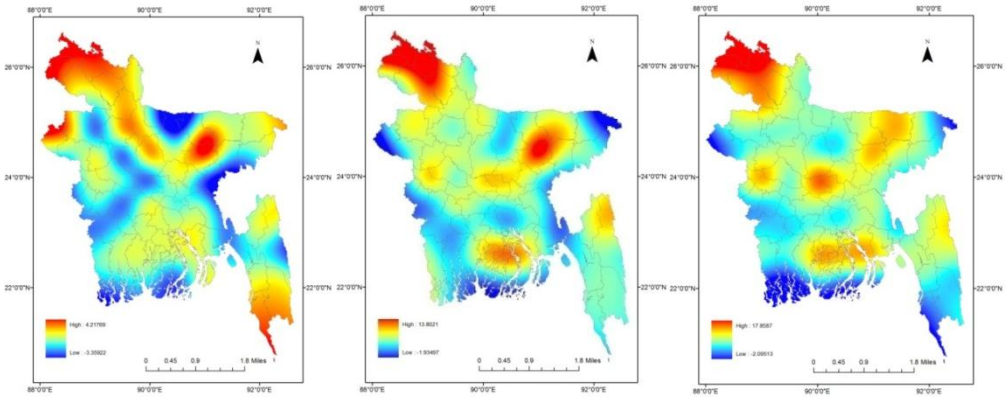

Fig. 4. Spatial distribution of changes of days when precipitation is more than 20 mm over Bangladesh for future time slices of 2020s, 2050s and 2080s from baseline year 1980s, respectively (from left).

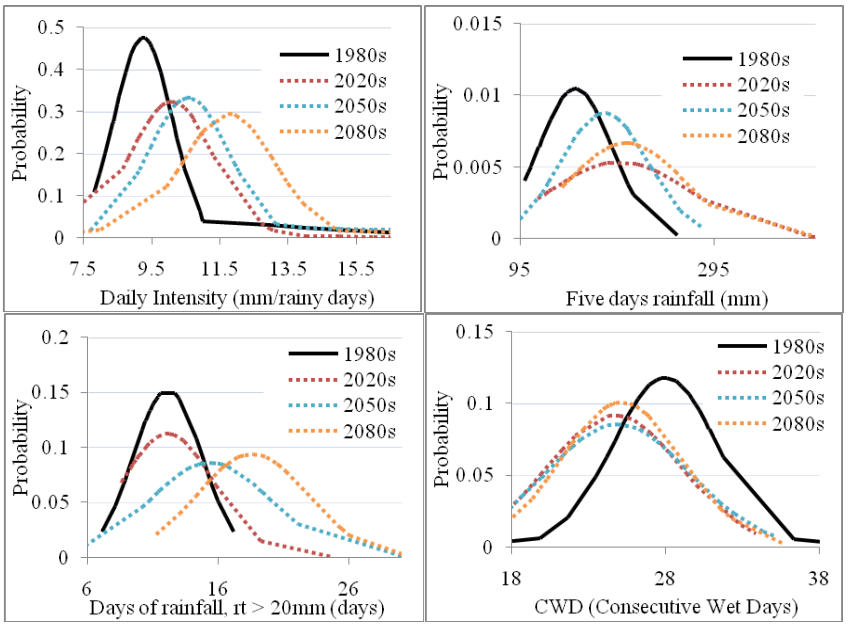

Fig. 5. Probability distribution functions (PDFs) of daily intensity (mm/rainy days), Five days rainfall (mm), number of days when rainfall > 20mm, and consecutive wet days over Bangladesh.

CONCLUSION

Changes of intensity, duration and frequency of the precipitation extremes are examined through a number of widely used indicators. Using results from regional climate models, future changes of extreme climate event has been quantified which would have profound impacts on human society, natural resources, and ecosystem. It has been found in general, that intensity and frequency of extreme events will be increasing. Monsoon precipitation exhibits increasing trends which is an indication towards the wetter climate, with notable increases in summer monsoon precipitation extremes

ACKNOWLEDGMENT

This research has been performed at the Institute of Water and Flood Management of Bangladesh University of Engineering and Technology (BUET). The authors gratefully acknowledge BUET for providing the resources and facilities needed to carry out the research successfully. The authors would also like to acknowledge the Met Office, Hadley Centre, UK, for providing PRECIS software and Lateral Boundary Conditions (LBCs) data.

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ID 21 **A3-02**

Rural Households Motivating to Biogas Technology in Bangladesh: Perspective of Environmental and Financial Issues

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ABSTRACT

Bangladesh is already threatened to regenerating limit of biomass below exist compare to its demand. Biogas produced from biomass under anaerobic condition could have played a role to mitigate the existing energy crisis and environmental degradation. The paper estimates environmental factors as well as economic, social and technological factors for adopting the biogas users in Bangladesh. Cross section data have used to estimate the relationship between adoption procedure and partial budgeting, and two- sample mean t-test has applied for statistical mean differences of various factors. The result found comparison to mean value of environment and economic factors have no statistical difference, but compare to social and technological factors have meaningful statistical difference for considering the adoption of biogas plants. Partial budgeting approach estimates the net change value is positive (21645.66 Taka per plant) means of biogas technology is a profitable business considering of economic and social issues.

INTRODUCTION

BIOGAS is a renewable form of energy, could supplement conventional energy sources. It is produced by anaerobic fermentation with consists of methane between 40% and 70%, the remaining being mostly CO_2, hydrogen sulphide and others trace gases [9]. About 16 million family size domestic biogas plants are functioning across the world. Successful use of biogas technology is the result of not only gas production and bio-fertilizer production but also other environmental and social benefits including sanitation, reforestation and reduction of imported fuel oil [8]. Smoke-free indoor cooking systems attract to the rural people for reducing ocular and respiratory infections and they lead to diminishing the family expenditures. It has a growing popularity across the country in Bangladesh where about forty thousand small scale biogas plants are functioning since 1972 and contribute to national economy [5].

Environment-friendly bioenergy production could be an instrument for rescuing the existing energy problem of Bangladesh where having potentials of fulfillment by 10 percent of total energy [2].About 60% of total energy consumption of the country is being met from biomass. The government targets of electricity generation by renewable energy technologies (RETs) are 5% of the total power generation by 2015 and 10% by 2020 [12]. Government has actively participated through subsidy distribution to the biogas users extending over the country.

Researchers have been conducting various studies of biogas plants in developing countries. Various advantages and few obstacles by using the gas have been mentioned, as have been positive externalities [14], opportunities and constraints [1], socioeconomic impact in rural area [6] and the estimated costs and benefits [7]. But, former research has not emphasized which motivating factors rural people have for taking the decision on plant implementation with considering the partial budgeting in developing countries.

The present study attempts to determine key factors influencing biogas adoption in rural areas in Bangladesh and to estimate the partial budgeting of new biogas plants. The research will emphasize environmental impact as well as financial issues in relation to biogas plants.

This paper at first intends to study the previous findings in relation to find the importance of biogas technology and second section covers the materials and methods. Result and conclusion with policy recommendations are in the final part of this paper.

MATERIALS AND METHODS

This study based on a survey conducted period of June to September 2011. Primary data collected from 150 households. Purposive stratified random sampling technique has applied due to the number of biogas users in comparison to total number of households was rather smaller in the sample areas.

The motivating factors divided into four major groups including environment, economic, technical and social issues. Partial budgeting approach useful for estimating the net effect of biogas implementation. Partial budgeting has four basic parts like increase income, reduction of costs, increase in costs and reduction of income. It has two groups including i) added income plus reduced cost and ii) added cost plus reduced income. Added income consists of additional earning income from using the savings time to other income activities and value of bio-slurry. Added costs consist of labour cost for regular use the raw materials, construction costs, interest, cowdung cost and maintenance cost. Reduced costs include save money from disease, less cost for alternative traditional fuel and chemical fertilizer cost and finally, it has not been found any activities reduce income for using of biogas technology.

Empirical Model: Two sample mean test has used for showing the statistically meaningful differences among the four major factors.

The null hypothesis H_O: $\mu(X_1)= \mu(Y_1)$ and
the alternative hypothesis H_1 : $\mu(X)\neq \mu(Y)$

$$t\ statistic = \frac{\bar{X}_1 - \bar{Y}_1}{S_{\bar{X}_1 - \bar{Y}_1}} \quad \text{with (n-2) d.f.....(1)}$$

Where $\mu(X)$ and $\mu(Y)$ are respectively the population mean of the two populations from which two sample have been drawn. X presents only environmental issues and Y will be used three facors including financial followed by social and technological issues. S and n denotes standard error and number of sample size. Stata 10.1 applied to calculate the statistical significant level in this paper.

RESULTS AND DISCUSSION

The main substrate of biogas plants was cow dung collected from grazing animals normally used into the agricultural field instead of burned as fuel. Farmers are in dire need of fertilizer for maintaining agricultural production as well bio-slurry organic fertilizer is eight times as high as the same quantity of chemical fertilizer as well as slurry has better manorial values as compare to the raw animal waste Biogas team [3]. Table 1 state that about 60% of sample farmers under environmental issue were considered the plant adoption in order to soil fertility preserve.

Greenhouse often forms from deforestation as well methane (CH_4) is the another source of greenhouse, though it is a minor by-product of burning coal and also comes from venting of natural gases as well as realize from the animal dung left in the field. The biogas burning provides clean and smoke free domestic fuel and alternatively, bio-slurry reduces the demand of chemical fertilizer assist to improve ecological friendly

farming system. The twofold benefits of the production of environmentally caring fuel and manure from the domestic farm animal is lost by either directly burning the same dung in the form of dried dung cakes or alternatively using it directly for producing organic manure creating the negative environmental impact [10].

The following Table 1 presents that 62% people were motivated to adoption of biogas with protection of deforestation.

Table 1. Motivating factors of biogas adoption in Bangladesh.

Factors	Motivating factors (percent)	Average (%)
Economical	Subsidy (60), Credit (48), Economic benefit (58), No. of livestock (69)	59
Social	Neighbours plant owners (58), NGOs (47), Advertisement (0), Local Government (0),	24
Technological	Time and energy savings(62), Fuel shortage (28), Service providers (6), Training (4)	26
Environmental	Health benefit(66), Forestation (62%), Soil fertility (60)	63

It seems to clear that rural people mostly motivating and considering environmental factors by 63 percent for implementing the biogas plant.

Good health is an acute part of well-functioning of economic development process. Biogas technology is producing the clean gas that makes the people with good health. Many hazardous incidences have been occurring by the burning of dung cakes, agricultural residues, firewood, etc. Since primitive age, women are used to cooking indoor tend to several health problems. These particles from the smoke create few respiratory diseases that are contact to the cooking as well as eye infections. An important issues has identified by uses the traditional cooking system increased the child mortality [13].

Usually, unmanaged cowdung is widely spread in the soil and it form few contaminated diseases include itching, vomiting, diarrhea, stomach cramps, skin related problem etc. Biogas reduces the probability of diseases. Cooking with biogas is easier as it not necessary keep the fire burning. About 66% of biogas users considered all these above health issues for taking decision on new biogas plants in rural areas in Bangladesh.

Second most motivating factor is economical aspects motivating the rural household by 59 percent. Thus, new technology should have economic benefits that execute the adoption policies. People are more attentive on economic issues for new technology implementation.

Social and technological issues have motivating power to enlarge the business of new biogas technology by 24 and 26 percent, respectively.

Table 2. Mean difference of environmental and others factors

Variable	Mean	Std. Err.	*p* – value	Mean-diff.
Environmental	62.66	2.35	-	-
Economical	58.83	2.29	0.96	1.81
Technological	25.33	1.60	0.00	15.70*
Social	26.00	1.39	0.00	13.56*

Note. *Significant at 1 percent level ($P<0.01$))

According to Table 2, two-sample mean value of *t* test of environment with economical factors, social and technological is 1.81, 11.91 and 15.70 with 1% level of significance. Thus, there is no significantly difference between motivating factors on environment and economic issues. But social and technological factors compare with environmental factor has significantly mean difference.

PARTIAL BUDGETING

Partial budgeting has four basic components with two columns. The left column calculates the positive effects and the right column estimates the negative effects discretely of a new business [11]. Added income normally estimated if the components are to be added. The following Table 3 shows biogas users normally save time and employed time to additional income earning and it is estimated 18009.34 BDT (Taka in Bangladesh). The saving times used for additional activities including handicraft, livestock and poultry rearing, home gardening, recreation, child care and teaching etc. Bio-slurry item added the income of 5714.41 BDT per year.

All additional costs are included that could be considered for production purposes. This list also includes the cost of labour, simple depreciation, interest of loan, cowdung and maintenance are 4000.00, 1112.53, 1481.82, 8499.95 and 400 BDT per year, respectively (Table 3).

Table 3 also presents diseases are diminishing due to adopts the domestic biogas plants. Respiratory diseases, eye problem were happen more before biogas technology adoption but after adoption the technology saved about 1015.00 BDT per year. Traditional fuels like firewood, dry dung, agricultural wastage uses have radically reduced and saving the money about 12103.11 BDT.

Table 3. Partial budgeting of a biogas plants (BDT/yr)

Added income (i)		Added cost (ii)	
savings time	18009.34	labour	4000.00
bio-slurry	5714.71	depreciation	1112.53
		interest	1481.82
		cowdung	8499.95
		maintenance	400.00
Reduced cost (iii)		Reduced income (iv)	
disease	1015.00	None	
alterna. fuels	12103.11		
alternative fert.	297.80		
Sub-total (v)= (i)+ (iii)		Sub-total (vi)= (ii)+ (iv)	
37139.96		15494.30	
Net change: 37139.96 - 15494.30 = 21645.66			

Finally Table 3 shows net change is positive (21645.67 BDT) indicating that this project could be adopted with considering the financial issues.

CONCLUSION

Rural people are aware with their existing livelihood with minimal environmental degradation, however, need to motivational activities to reaching optimal level of environmental balance. Environmental issues have been considering more for adopting biogas technology by the rural people rather financial, social and technological issues. Environmental and financial issues have not significant difference with respect to adopting the biogas plant but compare with social and technological having significant differences. Partial budgeting approach has been showing the positive net effect on taking decision on biogas adoption in rural areas. The finding indicates that biogas technology could be implemented across the country. Any component has not found apart from reduced income section of partial budgeting but has it adding income and reduced cost. Government has been playing a notable role to expanding the biogas technology throughout the county by sanctioning the subsidy

to the rural people and NGOs and private entrepreneur also assisting with government policy.

ACKNOWLEDGEMENT

I have received much assistance from different level of expertises. I could not mention all of them although, few of them are taking a place into my heart and fully acknowledged to them namely: Prof. Dr. S. Bauer, JLU, Giessen, Germany, German Academic Exchange Services (DAAD), Biogas Sample Users; Mr. Gofran, Grameen Shakti, Manjunatha Arahalli Venkataronappa, DAAD Fellow, JLU, Giessen, Germany.

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ID 32 A3-03

Co-operative Solar Energy: A proposal to Enlighten the Tribal people in Bangladesh

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ABSTRACT

Global warming is the crucial problem in present world and carbon emission is the main reason behind this. Of the total carbon emission of the world, 6% come from the household activities. The people of Bangladesh are too poor to use modern equipments to light their house at night. A survey was done on the tribal people to observe their energy consumption. They suffer a lot for the energy crisis and use kerosene lamps in their houses at night. These lamps give light with very poor luminance and emit much carbon which contribute to global warming and cause health hazards. We have a proposed a method to eliminate both of this. The proposal is to replace the kerosene lamps by the solar powered lamps which will give much luminance, stop carbon emission and reduce health hazards too. Since the rural people of Bangladesh are very poor, they cannot afford the complete solar system individually and our proposal is to establish a co-operative base solar power distribution system to facilitate them with light to enlighten their life. This will help in preventing global warming and will also contribute a lot to the socio-economic development of the tribal people as well as all poor people of the country.

INTRODUCTION

Global warming is the most talked concern in the world now. The developed countries are mainly responsible for the global warming but the countries like Bangladesh are affected more adversely by the global warming for being a coastal country.

The main reason behind global warming is the emission of carbon which reacts negatively with the ozonosphere of the earth. The developed countries like America are emitting a lot of carbon, in the other hand, trees are being cut down and global warming is accelerated due to this imbalance.

All the countries are trying to resolve this global issue, but the carbon emission is increasing day by day. The industries, brick fields, vehicles, electric power plants and so on are emitting carbon every moment in a large amount. The scenario is almost same all over the world. Thus the carbon emission has taken a great concern of the whole world.

In Bangladesh, people use Kupi (Kerosene Lamps) to light at night, who, more than 55%, are not connected with electricity and those who have the electricity also suffer a lot from load-shedding especially in time from evening to midnight [1]. By this time, rural people use these kupies to light their houses using kerosene as fuel which emits a huge amount of carbon.

A survey has been taken in three tribal villages of Bangladesh where more than 90% people are not connected to the national electric grid. The survey took their daily usage of fuel and made an advance calculation on the emission of carbon, the affects of the carbon emission on the nature and its adverse effect on the global warming.

These carbons are mainly emitted in the form of CO_2 (Carbon-di-oxide) which is not only harmful to the environment but also harmful to the human health. Especially in case of kupies, here the CO_2 are produced in the room where the people live. Additionally, the kupies produce smoke which harms human eyes very badly.

Considering all the adverse effects, a proposal is given to introduce a co-operative solar lighting system which will completely remove the carbon emission of the kupies by replacing them with solar lamps powered by the green energy of solar. This co-operative solar powered system will develop the socio-economic life of the rural poor people by reducing the fuel cost and giving them LED solar lights with more luminance, giving more light and more time to search their livelihood. Moreover, the school going children can't study due to lack of adequate clean light at night. This co-operative solar lighting system will give an opportunity to the children so that they can study at night and be educated for the upcoming future.

MATERIALS AND METHODS

Let's take a brief look in the Earth's present atmospheric condition. The atmospheric elements show the following percentages:

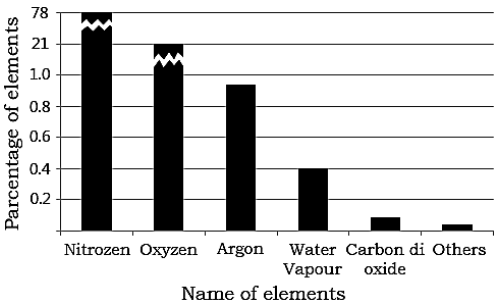


Fig. 1. Percentage of various elements of earth's atmosphere [2].

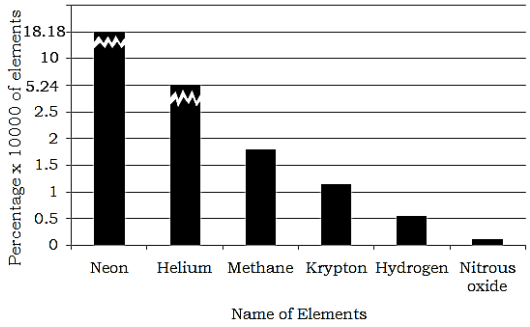
Here, the graph shows that the current concentration of the CO_2 in earth's atmosphere is 0.0387% or 387 ppm [2]. The main sources of this CO_2 consists of both the natural sources and man-made sources. The nature produces 220 giga-tones of CO_2 each year by the volcanic out-gassing, the combustion of organic matter, the respiration processes of living aerobic organisms, virus microorganisms from fermentation and cellular respiration and many more [2]. The man-made resources produce 13%-40% of the total CO_2 emission of the earth every year [2]. These resources include fossil fuels, power generation and transport, industries and so on.

The fossil fuels produce a minimum of 31.8 giga-tones of CO_2 each year (Data-2008) [2]. In this burning race of fossil fuels, kerosene plays a vital role too. Kerosene burning equation shows that:

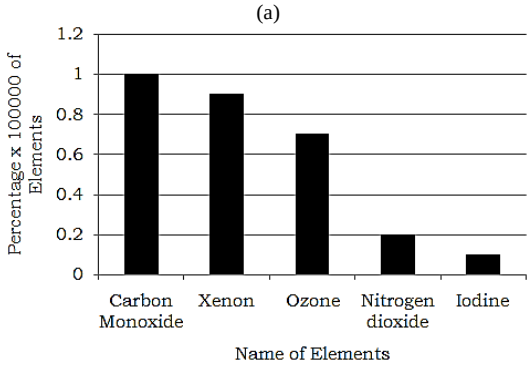
$$C_{12}H_{26}\,(g) + \frac{37}{2}\,O_2\,(g) \longrightarrow 12CO_2\,(g) + 13H_2O\,(g) \quad \ldots (1)\ [3]$$

Equation [1] shows, each molecule of kerosene produces twelve molecules of CO2 and each liter of kerosene produces 2.58 kg of CO2 [4]. This rapid production of CO2 affects the atmosphere adversely and gives rise to the global warming consequently.

This huge amount of carbon contributes to the global warming in a great extent. This scenario is only for a developing country like Bangladesh, but if considered for whole world, the amount will be too large. Of the total carbon emission around the world, 6% is emitted by the household activities [5].



(a)



(b)

Fig. 2. (a) and (b) Percentage of "other" elements of the earth's atmosphere in comparison with CO_2 [2].

To observe the carbon emission by the rural tribal people of Bangladesh by their household activities and to make a prospective solution, a survey was carried out in three rural tribal villages of Bangladesh. The most painful matter is that most of the tribal people are illiterate and live below the poverty line. They are so poor that they cannot afford two times meal a day to their family properly, where education is a far way.

The survey focused on their livelihood and to give them an approach so that they can change their life. Furthermore, the survey has concentrated on the education of their children and noticed that 90% of their children are getting schooling and surprisingly only 60% of them are studying at night due to the scarcity of fuel to light their lamps.

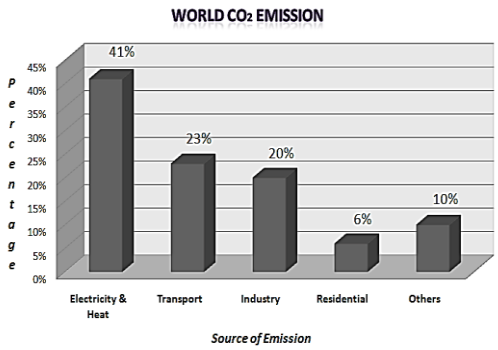


Fig. 3. Percentage of CO_2 emission from different sources.

Proposed Idea

The proposed idea after the consequent result of the survey is to replace the kupies by the green energy solar lamps. The lamps will be charged by solar energy as the villages are not connected to the grid. Since the initial cost of the solar system is very large, it is impossible for the poor people to implement a complete system individually. So the idea proposes to introduce a co-operative base solar lighting system.

A sample questionnaire of the survey is given in Fig. 4.

Name				
Occupation				
Religion				
Number of Family Members		Male		Female
Studying		1-5	6-10	11-12
Study at Night		Time of Going to Bed		
Number of Room		Number of Kupi		
Time of Use		Cost of Fuel		
Distance of Grid		Wants of Electicity		
Problem				

Fig. 4. A sample questionnaire of the survey

In this proposed system, there will be a central charging station which will be operated by the solar powered DC current system. The required solar PV panel will be bought by all the tribal families in a co-operative planning basis. The system will consist of only solar panel without DC to AC converter and backup batteries. This is because, the solar powered charger lamps need not AC current to be charged, and rather DC current is sufficient for charging. As all the people will charge their lamps at the day time, there is no backup battery needed. As these people don't have the capability to afford much for a whole system, this small system with only the solar PV panel and some wiring can be easily implemented by them in co-operative. Each tribal family will be provided with at least two solar lamps to enlighten their family, this number of lamps can be increased with their increased investment. When the implementation will be done and the project starts running, number of lamps can be increased. It is proposed to take BDT 4৳ (USD 0.05$) daily from each of the families for the further maintenance of the equipments and managing other miscellaneous expenses.

RESULTS AND DISCUSSION

Considering the carbon emission of the three villages surveyed, it has been observed that the emission of carbon from the kupies contributes in a great extent to the global warming perspective. The survey shows that each family of the tribal village uses an average of 250ml of kerosene per day and produces an average of 0.645 kg of CO2 every day. If we consider that about 50% people in Bangladesh are using kupies and burning kerosene as fuel, each family consisting of 5 people on average, then the total carbon emission in Bangladesh for the kupies will be 9.5 thousand tons per day and 3.48 million tons per year. Including the whole world's scenario, the amount will unimaginable.

Additionally, as these kupies are used inside the rooms, it produces a lot of smoke which is very hazardous for people's health especially for their eyes. Moreover, the produced carbon is mixed in the air of the room and causing various diseases as described by the surveyed people.

The proposed project will stop this emission of carbon completely by replacing the kupies with green energy solar lamps.

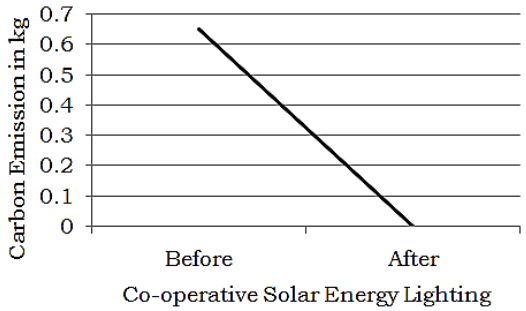


Fig. 5. Carbon emission has been stoppe after using co-operative solar lamps.

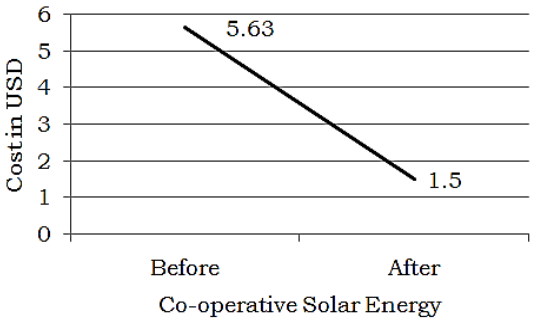


Fig. 6. Expense for lighting per month by a family has been reduced after using co-operative solar lamps.

Additionally, as the poor people are not capable of buying the solar panel individually, the proposed co-operative base solar panel installment and lighting system is very suitable for them to implement. This will cost a little for individual family and give them lights with more luminance to improve their socio-economic conditions, making them able to work at night, making their children able to study at night, removing the fuel cost and removing the health hazards too.

CONCLUSION

Co-operative base solar panel and light distribution system will be very economical and helpful for the poor people of the rural areas all over the world. This will help the people economically by reducing their fuel cost and give them a convenient place to live by stopping carbon emission and smoke production and thus removing health hazards. And more importantly this will stop the production of CO_2 by burning kerosene fuel with kupies and other burner lights completely. This stops carbon emission greatly and thus plays a vital role in reducing global warming and keeping the earth atmosphere parameters stable. Moreover, the introduction of green energy to these rural people will certainly strengthen their socio-economic condition; give them new era for searching their livelihood, giving their children a comfortable atmosphere to study and improving their lifestyle. Thus, this co-operative base solar energy and light distribution system is the perfect and real time idea for the rural people of the developing world and also for the world atmosphere.

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ID P10 **A3-04**

Potential of Informatization Agriculture in Bangladesh - Installation and Utilization of Field Monitoring System in Agriculture

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ABSTRACT

In order to grow up the agricultural potential in Bangladesh, an informatization agriculture might be one of the most effective tools for agricultural managements since many government and non-government organizations have made a lot of efforts to enhance their information technology. These efforts lead Bangladesh people to be able to access and utilize communication technologies such as mobile phone, Internet, etc. In fact, even rural people can use their mobile phones freely and can access the Internet at some community space which is managed by public or private organizations. In general, an inromatization agriculture is being considered as an applicable technology in the developed counties. However we could see strong potentiality of the informatization agriculture in Bangladesh through our survey and project. In this paper, we would like to introduce one of the trial verifications for the informatization agriculture by using simple web- based field monitoring system named FMS (Field Monitoring System).

INTRODUCTION

Bangladesh is an agricultural based country. The overall contribution of the broad agriculture sector at constant price is 19.95 percent of GDP in FY 2010-2011 [1]. About 43.6 percent of the total labor forces of the country are engaged in agriculture sector [1]. However, it has been achieved under massive and improper usage of fertilizer and pesticide. There are fears that such usage of the fertilizer and pesticide affect human health due to contaminated products and expand ground pollution.

In order to improve the chemical dependence farming in Bangladesh, several NPO, NGO, Research Institute, etc. have conducted enlightenment activities which are able to break away from chemical dependence farming. Our joint project named IGPF (Income Generation Project for Farmers using ICT) is also one of the project which aims at encourage the chemical free farming. IGPF is three years project proposed by Kyushu University, Japan and *sponsored by JICA (Japan International Cooperation* Agency). IGPF started since June 2010. IGPF aims to improve the farmer's living conditions and generate their income by providing the knowledge for chemical free farming through ICT. IGPF has two rural model sites namely Ekhlaspur (Ekhlaspur, Matlab uttar, Chandpur) and Kapasia (Mirjanagor, Sanmania, Aral Bazar, Kapasia, Gazipur) and 50 model farmers have conducted IGPF chemical free farming. Before starting the IGPF project, IGPF had conducted several surveys regarding the farming customs/ problems, the access to agricultural information and the usage of tele-center in Bangladesh. Here, "tele-center" is some community space which is provided by the government or non-government organizations. From those surveys, we found mainly following things; 1) Available agricultural information was limited, 2) Some of the farmers relied on the tele-center as source of agricultural information, 3) Many farmers wanted to their farm environment information to avoid the weather disaster. To summarize these findings, we might be able to point that the farmers want to get more information about agriculture especially for their farm environment and tele-center has a possibility to be a key station for information transmission. Regarding the transmission of farm environment information, it has some possibility to reduce the crop damages which are caused by weather variations and to obviate the reduction in yield. Therefore, if we created the transmission system, the system might increase the farmer's income.

Regarding the transmission of farm environment information in Bangladesh, field environment monitoring and web-based data provision system might have high possibility because the Bangladesh government has expand her information technology with the slogan "Digital Bangladesh" and as these results the opportunity which make the Bangladesh people to be able to touch the information technology have been rapidly increased [2]. Not only the urban area people but also even the rural people can use their mobile phones freely and access the Internet at tele-center [3]. It means that if we facilitated the web-based monitoring system, even the rural people could obtain the environment information by using their mobile phone or at the community space. From these trends of information technology in Bangladesh, we believe that a field monitoring system has a potential to be able to dramatically change the agriculture in Bangladesh.

In this paper, we would like to introduce our trial experience which we have installed our web-based field monitoring and data provision system into Bangladesh and to raise the problems and solutions related to installation and running of the FMS.

MATERIALS AND METHODS

A. Field Monitoring System

IT (Information technology) has been currently applied in several fields of agriculture to improve an agricultural productivity. There are many kinds of IT Agriculture applications that already used for supporting agricultural production such as environmental monitoring, precision agriculture including spatial data collection, precision irrigation and supplying data to farmers, facility automation including greenhouse control and animal-feeding facility, and so on [4]. Regarding the environmental monitoring, Hirafuji [5] and Fukatsuand & Hirafuji [6,7] have developed representative field monitoring systems called "Field Server" This system consists of monitoring sensor, built-in web-based data logger device and the self-programmed agent system. Field Server has following steps for collecting the monitoring data; 1) Agent systems collect the monitoring data, 2) The monitoring data is stored periodically into database server via Internet. Therefore, when the agent systems stopped irregularly the

Field Server could not collect the monitoring data. Such problem should be avoided especially for long-term field monitoring. In order to solve this problem, the authors have developed new conceptual field monitoring system named "FMS" [8, 9]. Instead of installing the agent systems, the function of e-mail sender have been installed into FMS. Device configuration of FMS is shown in Fig. 1. FMS mainly consists of sensors for environmental monitoring, logger circuit board with e-mail transmission, network supply unit and power supply unit. Logger circuit board has eight channel input port for analog sensors. A port capacity for analog-digital conversion is ten bit and input voltage is zero to five volt. FMS can be connected various sensors such as temperature, humidity, solar radiation, CO_2 concentration, electric conductivity, etc. The monitoring data is sent automatically to an e-mail server and then collected by database system. The data are protected securely since we use the commercial mail server. It means that we could keep the data even if some database system trouble was occurred. The database system can get the data after recovered.

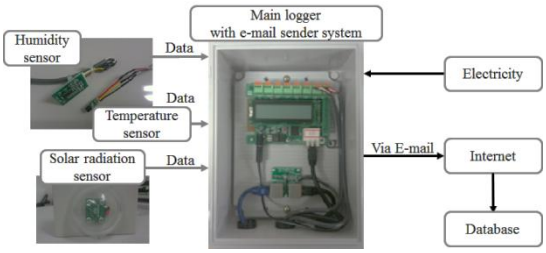

Fig. 1. Devices configuration of FMS

B. Data Provision System

For the construction of provision system for FMS information, we used the following open source ware; MySql (database system), PHP (programming language) and Xoops CMS (contents management system). Xoops CMS consists of the core system, contents manager, and modules. Various extension modules such as user management, news, forum, schedule, link etc. have been developed by many programmers in the world. These extension modules can be downloaded from related websites freely. Our provision system also has been developed as one of the extension module. The module mainly consists of the following sub-functions;

1) Configuration of the field monitoring device,
2) Monitoring data viewer and manager,
3) Multi-data viewer and manager, etc.

We can configure/manage the all monitoring conditions and adjust the monitor through the Internet browser.

C. Installation Site and Conditions for FMS at Bangladesh

Fig. 2 shows the installation site for FMS. We set the FMS at three sites in Bangladesh. Every three sites are related to IGPF project. IGPF office is the project coordination office at Dhaka, BSMRAU (Bangabandhu Sheikh Mujibur Rahman Agricultural University) is one of the cooperation partners of IGPF and Ekhlaspur is model site for chemical free farming. In Ekhlaspur we have use a community space called tele- center where have the Internet environment. Table 1 shows the running conditions for FMS. Due to their serious gap between supply and demand zy problem [10]. In order to supply the electricity during power outage, UPS (Uninterruptible Power System) is commonly used for electric devices. In this our trial monitoring the FMS at IGPF office and Ekhlaspur were connected to UPS after short period running without UPS. While the FMS at BSMRAU did not require the UPS since BSMRAU had a special electricity line supported by the government. The specification of UPS which is used at both sites is shown in Table 2.

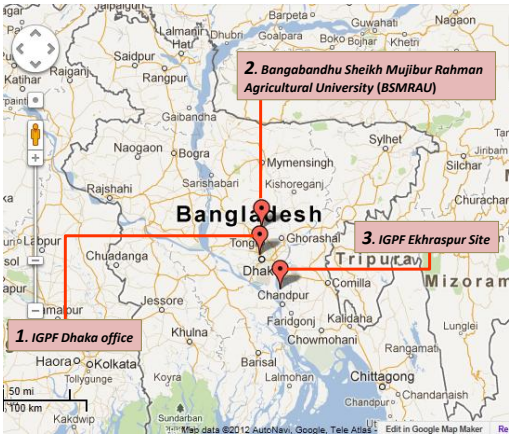

Fig. 2 Installation site for FMS

RESULTS

A. Availability of FMS

Fig. 3 show the test monitoring results obtained at Ekhlaspur during 15 June to 15 July 2012. The figures show the air temperature, humidity and solar radiation respectively. In these figures we could see long slope during three terms. These slopes indicated FMS could not obtain the data due to some errors. The main error was occurred due to power outage. Detail discussion about the power outage is in later section. Regarding the tendency of the temperature, the value might have been little bit high compared with sensible temperature. This might have been occurred by the sensor design of FMS since the FMS has been developed for plastic green house in Japan. Therefore we need to improve the design of FMS. However we could general variation for the weather by using FMS. The obtained data have availability for the decision making of agricultural activities.

Table 1 Running Conditions for FMS

Site	Starting Date for Monitoring	Measurement Items	Measurement Interval
1.IGPF, Dhaka	5, June 2012	-Air Temp.	2 minutes
2.BSMRAU	5, June 2012	-Humidity	5 minutes
3.Ekhlaspur	10, May 2012	-Solar Radiation	10 minutes
Support System for Power outage			
1.IGPF Dhaka	UPS was attached on 9 July 2012		
2.BSMRAU	BSMRAU has special electricity line		
3.Ekhlaspur	UPS was attached on 27 June 2012		

Table 2 Specification of UPS

Item	IGPF Dhaka	Ekhlaspur
Capacity	2000 VA	1000 VA
Battery	12 V × 2 = 24 V	12 V × 2 = 24 V
Supply hour	2 hour	2 hour
Required hour for full charge	8 hours	8 fours

B. Power Outage Problem

As we mentioned above we could not obtain the data from FMS during power outage term. The power outage problem is unavoidable problem in Bangladesh. Therefore it is important

for running FMS to deal well with the power outage problem. Fig. 4 shows the obtained solar radiation and power outage term at three sites from started date to 27 July. In these figures the black lines show the power outage term. We could see the long term power outage at IGPF Dhaka office from 11 to 23 July. This was due to the main FMS power line cut by mouse. It was really surprising thing the mouse had cut the power line for FMS, however, we eliminated this problem for the discussion of power outage. Obviously we could find that the effect of the special electricity line at BSMRAU and UPS at IGPF Dhaka office and Ekhlaspur. After we had set the UPS on 9 July at Dhaka and 27 June at Ekhlaspur, the blackout term were decreased at both the sites. Fig. 5 shows the frequency of power outage at three sites. Most of the power outage term was less than one hour. These results indicated that the UPS had enough capacity for running FMS to supply the electricity during power outage term. It means that if we consider the running of FMS and obtaining the general weather information through our FMS, the alternative power supply by UPS might be enough for FMS running.

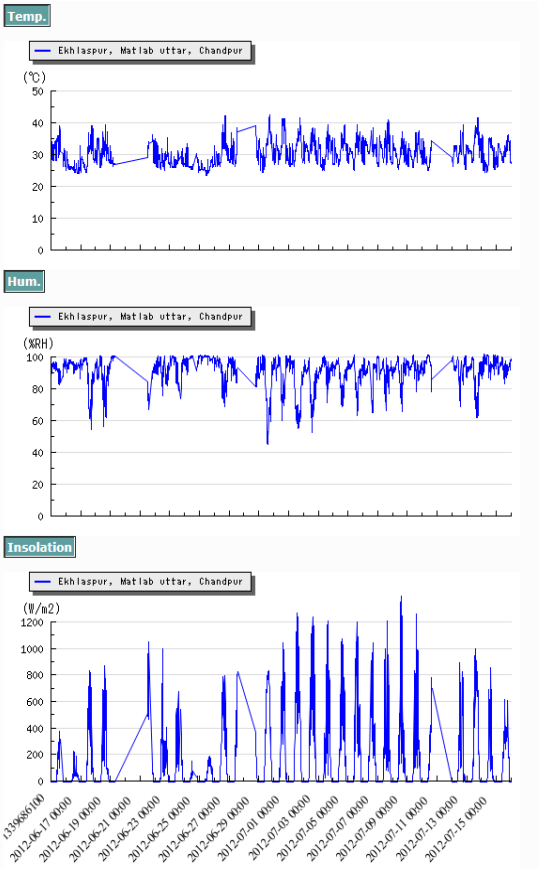

Fig. 3. Example monitoring results at Ekhlaspur
(View of FMS website)

DISCUSSION

A. How Can We Utilize FMS Information?

In the previous section we mentioned about the test monitoring results and running availability of FMS with UPS. From here, we would like to introduce the way how we can apply the FMS information to agriculture in Bangladesh. It is obvious that the weather information is important factor for agri- cultural activities since the farmer should decide their farming activities by checking the weather variation. Therefore if we could construct the information distribution system of FMS, the farmer could conduct correct farming. For the information distribution the FMS, information technology environment in Bangladesh might be effective because even the rural people have the environment to be able to use their mobile phones and can access to the Internet at their community space. We have already started the information distribution of FMS as a part of IGPF activities at Ekhlaspur tele-center. When the model farmers want to know tendency of the weather variation the farmers visit to tele-center or call to tele-center staff and get the information. And based on the information the farmers could decide their farming activities. For example, when high humidity level, which has a possibility to spread some virus disaster, continues for a few days the farmer protect their crops by using nylon film. In this way FMS information could help the rural farmer if we could cooperate with community space. Therefore we may need some tie-up with the government or some organizations which tackle the information distribution thorough information technology.

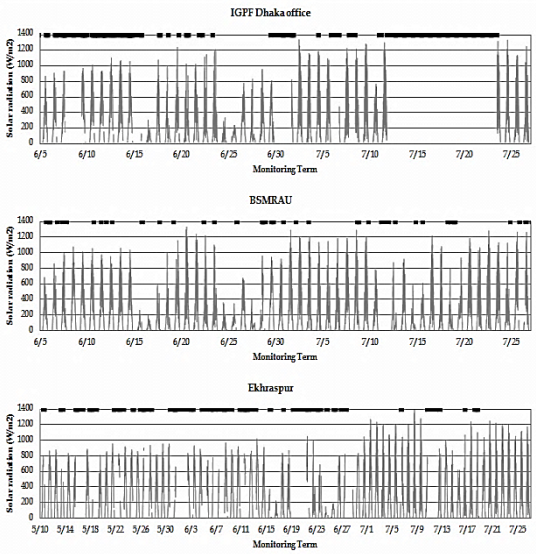

Fig. 4. Solar radiation and power outage term

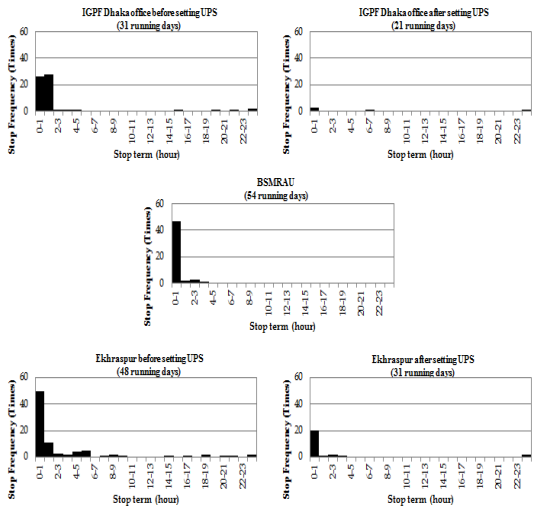

Fig. 5. Frequency of power outage

B. Sustainable FMS Monitoring

As we mentioned above, power outage is the big impediment to run the FMS. In this trial monitoring, we have used UPS to support the power outage. However, UPS has a limitation for sustainable monitoring of FMS since the capacity of electricity supply is only two hours. Even our monitoring term we could see long power outage term more than two hours. Lack of the monitoring information might be undesirable things for information distribution. In order to solve this power outage problem, a solar panel generation might be effective for the sustainable running of FMS. Therefore we have to develop new type FMS which is attached the solar panel generation.

By the way, we mentioned a little about the accident occurred by the mouse, some of the unforeseeable accident might be occurred in Bangladesh. Not only is the mouse, a theft also to be the impediment for sustainable monitoring. Therefore, it is one of the important factors for sustainable monitoring to make well protection.

C. Future Vision for Informatization Agriculture

Through this trial monitoring and test information distribution at tele-center, we could get a certain possibility of FMS information distribution at rural village. We could find that our IGPF model farmers seemed to get more information about agriculture. However, in the case of the information distribution at tele-center, the distance from the farmer's house to tele-center might be negative effect for the farmer. Actually some of the model farmers who live in more than two kilometer far from tele-center did not come to see the information frequently. From this, we may have better to consider the other way for the information distribution. One of the alternative ideas is a utilization of SMS (Short Message Service) of mobile phone. As mentioned above, even the rural people can use the mobile phone network and most of the rural people have their own mobile phone. Therefore, if we constructed an automatic FMS information distribution system through SMS, we could increase the convenience of information distribution. This work would be high priority work of our FMS information distribution.

CONCLUSION

In this paper, we discussed the utilization potential of FMS in Bangladesh. The following things could be found as some ideas, solutions, and improvements for running FMS and FMS information distribution;

1. UPS could support the FMS running to some extent. However in order for more sustainable running we might consider the utilization of solar panel generation as the alternative method of UPS.
2. For the sustainable FMS running we should care about not only the power outage problem but also every possible impediment such as capers by animal and thief.
3. We could see active farmers who want to get more FMS information at the tele-center. In order to respond to highly expectations from the farmers we should increase the measurement items of FMS and provide the effective information to the farmers.
4. In order to distribute FMS information more effectively we need to consider the information distribution system which utilizes the SMS of mobile phone.

ACKNOWLEDGEMENT

This research was achieved as one of project activities of IGPF which founded by JICA. Here, we would like to express great appreciation to JICA.

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ID 19 **A3-05**

Strip Tillage Seeding Technique for Utilization of Residual Soil Moisture in Dry Land Farming

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ABSTRACT

Strip till seeding system is a conservation tillage operation which employs tilling the planting strip, seeding, fertilizing beside the seeding line and seed covering simultaneously and utilize the residual soil moisture for crop establishment especially in dry areas. Strip tillage experiment was conducted during 2008-11 for wheat, lentil and mungbean cultivation in Rajshahi, Bangladesh. The seeder creates 4-6 cm wide planting strip and produce good seed soil contact which facilities better plant stand. Seed placement vary 5-7 cm below the soil surface depending the moisture availability in the soil. The grain yield is comparatively higher than conventional methods. The rotating strip blades can operate through moderate crop residues field without plugging. Effective field capacity of the seeder increased 19% and fuel consumption reduced 21% compared to conventional seeding system. Strip till saved cost of planting 62% compare to conventional seeding method. Break-even point of strip tillage seeder was 4.0 ha.

INTRODUCTION

Agricultural machinery play an important role to reduce drudgery of farm works as well as minimize operational time and production cost. Land preparation and sowing are expensive and time-consuming operations for up land crops cultivation. Proper placement and distribution of seeds and fertilizers into the soil is necessary for good germination and plant establishment for better yield [1]. Strip till planting system in which tilling the planting strips and seeding can be accomplished simultaneously thereby reducing the number of field operations which is environment friendly because of low fuel consumption and less soil erosion. In this system land is remain untilled between the two seeding lines. No till facilitates improvement of soil quality, reducing the surface soil erosion and keep residue over the soil surface which restrict moisture loss [2, 3].

Farmers of Bangladesh are becoming more dependent on mechanical power. Nowadays, two wheel tractors (power tillers) are available all over the country. There are about 350000 two wheel tractors in operation [4]. Survey results showed that 11%, 17% and 55% of wheat growers used power tillers for cultivating wheat in 1991, 1992, and 1994, respectively [5, 6]. Wheat sowing period is very limited in Bangladesh. After harvesting of T. Aman (Monsoon rice), farmers do not have enough time for land preparation with traditional ploughing system.

Delay in planting is one of the main constraints to increasing wheat yields; generally 10-22 days are required for conventional tillage. This conventional tillage includes 4-5 passes plough followed by 3-4 times laddering. Power tiller operated seeder (PTOS) performs tillage operation, seeding in line and seed covering simultaneously. During last few years, performance of strip till seeder was demonstrated at different locations of North West Bangladesh. Strip tillage system crop residue on the soil surface helps to preserve moisture and resist growing weeds especially in dry farming areas.

The objectives of the study were (i) to establish crop under strip tillage seeding system utilization of residual soil moisture; (ii) to demonstrate and evaluate strip tillage performances for different crops cultivation in dry areas and (iii) to compare the cost of planting by strip tillage seeder than that of the conventional methods.

MATERIALS AND METHODS

Power tiller operated seeder (PTOS) has 48 numbers of rotating blades for shallow tilling the soil. The seeding part attached with power tiller replacing the rotavator part of the power tiller. In strip till system, rotating tynes were reduced to 24 numbers. Only 4 tynes remain in the gang at front position of seed furrow opener for tilling and creating a strip in the soil. Between the two seeding lines soil remain untilled. The tynes of the seeder were rotating at the speed of 450 rpm. Seeding operation was completed by the drill in one pass –as tilling and creating a strip of wide 4-6cm, seed and fertilizer placed in the strip, and seed covering by the press wheel of the drill (Fig.1).

Fig. 1. Strip till seeder

The experiment was conducted in Chargat, Godagari, Puthia area of Rajshahi district during 2008-2011. Wheat, lentil planted after T. aman harvested land and mungbean planted after wheat harvest immediate after harvesting the previous crop utilize the residual soil moisture of land. The average height of the rice residue was 15 – 20 cm. Recommended fertilizer was used and placed during seeding operation. Each block was separated into three parts for the three methods of tillage: (i) Strip tillage (ii) minimum tillage by PTOS, that means full shallow tillage in one pass and (iii) conventional methods. Collected data were (i) Depth of seed placement (cm), (ii) Travel speed (km/hr), (iii) Effective field capacity (ha/hr), (iv) Field efficiency (%), (v) Fuel consumption (l/hr), (vi) No. of plant/m^2, (viii) Soil moisture (%), (ix) Yield/m^2, (x) Cost.

RESULTS AND DISCUSSION

Field observations and comparisons with the standard tillage system over 3 years period in several farmers field indicate that wheat can be established immediate after rice harvest using the strip till system. Performance of strip tillage, minimum tillage by power tiller operated seeder (PTOS) and conventional tillage were shown in the Table 1.

The effective field capacity of the seeder in strip till method was (0.19 ha/hr) more than minimum till seeding (0.15 ha/hr). In strip tillage method, seeder moved comparatively faster (19%) than the minimum tillage due to work load variation. It was also found that the fuel consumption was less (21%) than normal minimum till. It was due to the load reduction on rotary blades. During operation it was also found that the crop

residue were chopping by high speed rotation of the rotary tynes and not plugging the rotary units.

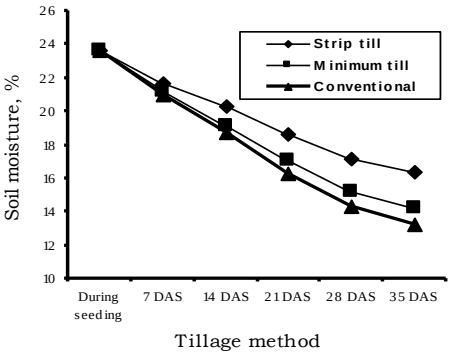

Fig. 2. Soil moisture variation after seeding

Fig. 3. Strip till wheat plot

Farmers can complete seeding operation in strip tillage method one hectare land by 5.26hrs compare to 6.7 hr and 17.5 hr of minimum till and conventional method, respectively. Strip till save time 69% compare to conventional method. Depth of seed placement was found uniform (3-4 cm) in the strip tillage and seeding depth can be controlled accurately. Depth of planting strip can be increased up to 5-7 cm. Width of strip 4-6 cm was enough for crop establishment. Plant population varies among the different seeding methods (Table 2). Plant population in strip tillage and minimum tillage methods were higher due to the utilization of residual soil moisture but in conventional system plant population was less due to moisture faster loss (Fig. 2). Applied seed rates 120 kg/ha were same in both strip till and minimum till method. The farmers were generally used seed rate 155 kg/ha which was about 29% higher than recommended. Fig. 3 showed the plant stand under strip till method.

Crop yield was higher in strip tillage method due to more soil moisture during plant establish period. Necessary plant nutrient was available near the root zone area of crops. In conventional method plants growth was uneven due uneven depth of planting. Wheat yield in strip tillage (4.90 t/ha) which was 41% higher than conventional (3.5 t/ha) method (Table 3). Similarly lentil and mungbean yields were more than that of conventional method.

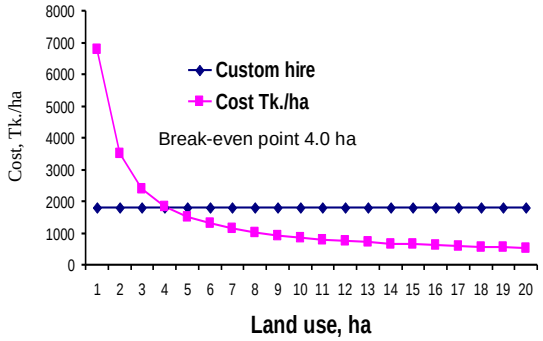

Fig. 4. Break-even use of strip till drill

The cost of planting in different planting methods is shown in Table 4. Among the three planting methods the cost of strip tillage system was minimum (Tk.1850.0/ha) and the highest was in conventional method (Tk.4900.0). Strip till saved cost 62% compare to conventional method. The planting cost can be afford by the farmers both strip tillage and minimum tillage methods.

Beak-even point of crops for strip till drill is shown in Fig. 4. Break-even point is calculated on the basis of fixed cost and variable cost of strip seed drill considering purchase price, interest on investment, machine life, etc [7]. Cost per hectare decreased with the increase of land area used annually. Breakeven point of strip tillage was found 4.0 ha which indicated that it is the point where no loss or no profit occurs. The owner of the strip seed drill must plan for profitable use of seeder over 4.0 ha land yearly.

Table 1. Working performance of strip till and minimum till seed drill

Sl. No.	Parameter	Strip tillage	Minimum tillage	Conventional
1	Travel speed (km/hr)	2.5	2.1	-
2	Effective working width, cm	120	120	-
3	Effective field capacity (ha/hr)	0.19	0.15	-
4	Drive wheel slippage (%)	6	8	-
5	Fuel consumption (lit./ha)	5.8	9.3	13.6
6	Total time requirement (hr/ha)	5.26	6.7	17.5

Table 2. Comparative performance of strip tillage, minimum tillage and conventional tillage method in 2011

Parameter	Strip tillage			Minimum tillage			Conventional method		
	Wheat	Lentil	Mung	Wheat	Lentil	Mung	Wheat	Lentil	Mung
Seed rate (kg/ha)	120	25	20	120	25	20	155	35	30
Seeding depth, cm	4-5	3-4	4-5	3-4	3-4	3-4	5.3	3.4	4.6
Width of strip, cm	4-6	4-6	4-6	-	-	-	-	-	-
Plant population/m^2	286	195	30	275	205	28	255	180	23-35

Table 3. Yield performance of strip tillage over minimum tillage and conventional method

Tillage method	Crop yield (t/ha)		
	Wheat	Lentil	Mungbean
Strip tillage	4.96	1.4	1.5
Minimum tillage	4.80	1.2	1.0
Conventional	3.50	0.8	0.75
SE	0.5	0.3	0.6
(CV%)	12	14	11

Table 4. Cost of planting in different tillage methods

Sl. No.	Planting methods	Cost of planting (Tk./ha)
1	Strip tillage	1850.0
2	Minimum tillage	1873.0
3	Conventional method	4900.0
	SE	247
	CV (%)	13

1 US$=Tk.84.0

CONCLUSION

Based on the results of strip tillage crop response and field performance evaluation of this system the following opinions and conclusions were made.

1. Strip till produced a good seed bed 4-6 cm wide and maintains better seed-soil contact. Plant populations were more due to extended period utilization of residual soil moisture.
2. The rotating strip blades can operate in moderate residues without plugging.
3. Seed saving is 29% over conventional broadcasting seeding method.
4. Field capacity of the strip seeder increased 19% and fuel consumption reduced 21% compared to minimum full tillage system.
5. Strip till saved cost of planting 62% compare to conventional seeding method.

ACKNOWLEDGMENT

The authors are pleased to acknowledge International Maize and Wheat Improvement Centre (CIMMYT) and Australian Centre for International Agricultural Research (ACIAR) for financial and technical support to conduct the research works both on station and in the farmers' field.

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ID P6 A3-06

To Date Situation of Highly Pathogenic Avian Influenza (HPAI) H5N1 in Bangladesh: A Review

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ABSTRACT

Highly Pathogenic Avian Influenza (HPAI), a pandemic disease around the world, had first spread its arm towards Bangladesh in the early 2007. Since then the country has been going through the epidemic waves of the disease every year resulting a huge destruction in the poultry industry. Recently introduction of new mutant of the virus has also found indicating new threat to the country. Many risk factors are found to be responsible for the spread of the disease among which human activity seems to have a significant effect. Zoonotic risk of the disease is nowadays also in increase. The present review has been carried to show the current situation of HPAI in Bangladesh which might help to determine the further studies needed to be done in this field in the country.

INTRODUCTION

The world has been suffering from the global threat of highly pathogenic avian influenza (H5N1) since its first introduction in 2003 from Far East and Southeast Asia. HPAI is responsible for the death or forced culling of more than 400 million domestic poultry and has caused more than $20 billion economic damage all over the globe [1]. This disease has taken attention of researchers and veterinary practitioners for its both veterinary and public health concern. Although in Bangladesh first outbreak occurred in the beginning of 2007 [2], the disease has already caused a huge damage to the poultry industry within the course of 5 years circulation in the country. Many studies regarding various aspects of this disease have been done already. Still FAO has urged more preparedness and surveillance due to the resurgence of HPAI caused by new mutant of the virus in last year. In Bangladesh the huge population and poor enforcement of legislation increase the gravity of threat of pandemic outbreaks as well as socioeconomic effects due to huge loss of life. Therefore more careful investigation needs to be taken in the country to stimulate the preparedness and response activities against the outbreaks. This review article has summarized all available epidemiologic and clinical studies conducted about HPAI along with the updated information of the disease throughout the country.

OUTBREAK OF *HPAI* IN BANGLADESH

First outbreak of HPAI in Bangladesh was noticed in February 2007 [2]. Though the exact origin of outbreak is not confirmed yet, but it is suspected that migratory birds can be the main source of this deadly H5N1 virus in Bangladesh [3]. Spread of HPAI outbreak in Bangladesh was with a latitudinal direction [4]. Until April 2012, a total of 545 cases (22 cases in 2012) of Avian Influenza have been reported in 53 of the 64 districts in Bangladesh [2]. According to FAO, Bangladesh is one of the 6 countries (Bangladesh, China, Egypt, India, Indonesia and Vietnam) where H5N1 is endemic in poultry [1]. Since the first HPAI outbreak, Bangladesh has faced five epidemic waves in five consecutive years where 2008 has seen the highest number of outbreaks followed by two mild waves of outbreak in 2009 and 2010.HPAI again rose progressively in 2011 with 164 events on that particular year. In the year 2012, 22 cases have already been identified. In each wave of outbreak involvements of new districts indicate the continuous spreading of the virus all over the country [2]. HPAI cases in Bangladesh are more available during cool (average daily temperature of 15-20^{0}C) and dry winter months (December – March), whereas no event was identified during the hot (average daily temperature of 30^{0}C) and wet summer season (June –August) [5].

In Bangladesh, from the beginning of HPAI outbreak only clade 2.2 viruses were found to be circulated. A recent study [6] reported a new introduction of clade 2.3.2 and 2.3.4 HPAI viruses in Bangladesh. From these new clades 2.3.2 viruses found phylogenetically related to the newly designated clade 2.3.2.1, which according to FAO is the reason of recent increase in outbreaks of HPAI across East Asia [1]. Though clade 2.3.2 viruses in that particular study found in crow, quail and duck but the author speculated it is obvious that the same virus is also circulating in chickens.

CONFIRMATION AND CONTROL STRATEGY OF *H5N1*

Diagnosis of HPAI outbreak in Bangladesh is based on 3 stages [5]. Normally HPAI outbreak is suspected with its high morbidity and mortality along with the observation of clinical signs in chicken. Biswas et al. (2011) identified major signs observed during HPAI outbreak in chickens in Bangladesh [7]. In almost all cases in both commercial and backyard chickens combs and wattles became cyanotic. Edematous heads & faces and drowsiness & huddling signs were more common in backyard chickens. On the other hand diarrhea and neurological dysfunctions were mostly found in commercial chickens. Other important signs were ecchymotic discoloration of the lag shanks, indurate crops assessed by palpation and excessive lacrimation. Secondly, a positive rapid antigen tests (The Flu Detect^{TM} Antigen Capture test, Synbiotics Corp., San Diego, CA) for Influenza A are available in the farm or at a regional laboratory. Hemagglutinin-5 is detected by a positive reverse-transcriptase polymerase chain reaction test at the National Reference Laboratory for HPAI near the capital Dhaka. For the confirmation of H5N1 and sequencing of isolates tracheal samples from chickens are sent to the Veterinary Laboratories Agency, UK.

In Bangladesh, vaccination against Avian Influenza in chicken is prohibited. The common measures applied after detection of any case are commonly: stamping out, movement control inside the country, disinfection of infected premises/ establishments. Usually there is no treatment for affected population (OIE).

RISK FACTORS OF *HPAI*

Several epidemiologic studies have revealed that various risk factors are responsible for the continuous spread of HPAI in Bangladesh. The ecological factors causing spread of the disease in sub-district level were studied by different authors. The important ecological risk factors for outbreaks of HPAI in any sub-district in Bangladesh were determined by Loth et al. (2010) [5]. According to their findings three significant risk factors were identified: the quadratic log-transformation of human population density, the log-transformation of the total

commercial poultry population and the number of roads per sub-district.

A study by Ahmed et al. (2012) showed the other ecological determinants related with the risk of HPAI-H5N1 outbreaks at sub-district in Bangladesh [8]. The most important determinants found were: migratory birds' staging areas, river networks, live bird markets and literacy rate. 21 species among the 244 species of migratory birds' visit in Bangladesh can be carrier of HPAI H5N1 [9]. The staging areas of migratory birds and HPAI outbreaks hotspots in Bangladesh coincide with east and central Asian flyways [10]. The finding of Ahmed et al. (2012) [8] supported the relation of HPAI outbreaks with presence of migratory birds' staging area in a sub-district. Moreover increased risk of HPAI outbreak was also found in the sub-district crossed by or situated at the banks of main river networks. The reason might be dumping of dead chickens or transporting of infected poultry or contaminated poultry products through a river [11-13]. Risk of HPAI outbreaks was higher in sub-districts with high number of live bird markets. Literacy rate was also an important finding for the awareness about HPAI. The sub-district with higher literacy rate had higher probability of reporting outbreaks. Unlike to other south-east countries [14-16], duck density and crop intensity did not show any association with outbreak of HPAI in Bangladesh. This might be because of different duck husbandry in Bangladesh.

Risk factors associated with farm and farm managements have also been well studied. In Bangladesh, there are 3 kinds of poultry rearing system: large commercial farm, small commercial farm and backyard free range poultry rearing system. In large commercial farm disease spread found to be dependent on two main risk factors: farm accessible to feral & wild animals and footbath at entry to farm/shed [3].

Small commercial poultry farming acts as an important factor in economy and living of many people of the country. Biswas et al. (2011) has checked the risk factors of small scale commercial chicken farms (FAO defined system 3) [17]. According to their findings House Crow (*Corvus splendens*) plays an important role to transmit HPAI viruses to the commercial chickens. In 2008 HPAI H5N1 found as the causative agent for the mass mortality in crows. Other sources of contaminants to the chickens of small commercial farms were: practice of exchanging egg trays with market vendors and contact with infected backyard chickens due to poor fencing systems in the farms.

About 89% households in rural area in Bangladesh rear backyard poultry [18] having free movements. Such free access of poultry to its environment makes them more prone to HPAI. Biswas et al. (2009) identified major risk factors causing HPAI infection in backyard poultry [19]. The main risk factors found were: Nearby (<0.1 km) body of water, contact with domestic pigeons and offering slaughter remnants of purchased chickens. Water bodies can be a cause of infection because those places are often shared by virus-shedding ducks. Pigeons can be a mechanical transmitter of virus as they easily get close contact with secretions of the infected or dead chickens or fomites. Because of the economic situation of poor people in Bangladesh they often sell apparently healthy and even clinically diseased chickens at cheap price. This allows other villagers to offer the remnants of slaughter, inedible parts of those diseased poultry to the healthy birds. However, Biswas et al. (2009) also found that keeping chickens and ducks in different shelters at night can reduce the chance of contamination [19].

ZOONOSES AND OTHER ENVIRONMENTAL RISKS

Besides the risks for the host population HPAI also poses a great threat of human pandemic and other environmental risks. Until May 2, 2012 total number of confirmed human cases of avian influenza A (H5N1) throughout the world were 603, among them 356 were fatal [20]. This picture clearly describes the zoonotic threat of HPAI. Since 2007, there were 6 human H5N1 cases in Bangladesh without any fatality. The first human event reported in 2008, after that 2 cases found during 2011 and 3 more cases have already diagnosed in 2012 [20]. This figure might indicate an alarming increase in human infection with this virus in the country.

Cases of deaths by H5N1 have been reported in several animals probably after ingestion of contaminated birds. For example, in Thailand H5N1 has been found in cat [21], dog [22] and tiger [23]. Birds other than chickens are also not out of risk. Several species of birds like crow, quail have already recorded to be found as H5N1 positive. In Bangladesh, poor hygienic condition can increase such risk of HPAI infection in different species of animals and birds.

CONCLUSION

Poultry industry is a very important sector in an agro-based country like Bangladesh. HPAI, the deadly viral disease is destroying the interest of poultry farming all over the country. The zoonotic risk of this HPAI has also been posing an alarming threat. This review has summarized all the published works done about HPAI in Bangladesh, but there might be some other unpublished works also done in this field could not be included in the current review because of unavailability. The present review argue that although various studies have already detected the key factors responsible for the spread of the disease, still specific effective measures and regulations for the control of the disease are yet to be found. To save the poultry sector in the country from this pandemic disease more attention should be given on the research about this disease.

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ID 5 **A3-07**

A Solution of Power Crisis in Bangladesh: Prospect of Solar Tower Power Plant

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ABSTRACT

In this work several contemporary research papers and books regarding solar tower power plants have been reviewed and propose a solution of energy crisis by incorporating solar tower system in power sector of Bangladesh. She is situated between 20 o13 ′40′′ –26 o13′80′′ degrees north latitude and 88 o10′10′′–92 o14′10′′ degrees east, which is an ideal location for solar energy utilization. Daily average solar radiation varies between 4 and 6.5kWh/m2. Maximum amount of radiation is available in the month of March–April and minimum on December–January. Out of 365 days we have 340 to 345 days of sunshine. Power tower systems, reflect and concentrate sunlight onto a central tower-mounted receiver where the energy is transferred to working fluid. The main advantage of solar power towers is the ability to provide high-temperature superheated steam, leading to higher power generation efficiencies without environmental pollution.

INTRODUCTION

The standard of living and quality of life of a nation depend on its per capita energy consumption. Bangladesh is one of the poorest developing countries (147 out of 179 in the IDH rank established by the PNUD and 83% of the population living with less than $2 per day). Here per capita energy consumption in 2005 stands at 227 kgOE (kilograms of oil equivalent), which is much below the world average of 1778 kgOE. The energy consumption mix was estimated as: indigenous biomass 60%, indigenous natural gas 27.45%, and imported oil 11.89%, imported coal 0.44% and hydro 0.23% [1]. Bangladesh has one of the lowest per capita power generations (only 236 kWh) in the region and about 51% of its 155 million populations have no access to power. The government of Bangladesh has undertaken a master plan under the Vision-2021 to reach electricity facilities to every village of the country. Approximately 48,754 villages out of 87,372 villages have been brought under electricity facilities till April 2011[2]. Even then, the national power generation capacity is only 4500-4750 MW against a peak demand of 6000 MW. At the current rate of increase in consumption 10% annually [3]. The generation predominantly depends on the indigenous natural gas accounting for about 88.39% of the generated power. Rest of the power is produced by Diesel, Hydro, and Coal. The cumulative efforts of exploration for oil and gas resources in Bangladesh has resulted in the discovery of 23 gas fields of various sizes producing 2000 mncft of natural gas . Currently, from our 5 discovered mines only Barapukuria Coal Mine is producing at this stage. In 2008 it produced about 0.8 million tones. The estimated reserves of coal are close to 3300 million tones, while the proven reserve is about 884 million tones. The scope of hydropower generation is very limited in Bangladesh because of its plain lands, except in some hilly region in the northeast and southeast parts of the country. At present only 230MW of hydropower is utilized in Karnafuli hydro station through 5 units of Kaplan turbine [4]. Traditional energy sources, i.e., those that produce a substantial amount of the power currently used, include coal, oil, natural gas, hydropower, and nuclear fission. Bangladesh is situated between 20°13`40`` to 26°13`80`` degrees north latitude and 88°10`10`` to 92°14`10`` degrees east, which is an ideal location for solar energy utilization. Daily average solar radiation varies between 4 and 6.5kWh/m^2. Maximum radiation is available in the month of March–April and minimum in December–January. Out of 365 days we have 340 to 345 days of sunshine; even if it is raining we have sunshine in between the rains. The solar thermal technologies that are of interest in Asia are solar hot water systems, solar dryers and solar cookers. While solar water heaters for hotels and hospitals could bring down electrical loads, solar cookers should conserve biomass and solar dryers would be useful for drying timber, paddy, fruits and vegetables with benign environmental effects. Only BRAC has propagated this technology in the field by installing 260 Hot Box cookers. The NGO has a future plan to install more 5000 Hot Box cookers all over the country [5].

SOLAR THERMAL POWER GENERATION TECHNOLOGIES

Solar Thermal Power systems, also known as Concentrating Solar Power systems, use concentrated solar radiation as a high temperature energy source to produce electricity using thermal route. Since the average operating temperature of stationary non-concentrating collectors is low (max up to 120°C) as compared to the desirable input temperatures of heat engines (above 300°C), the concentrating collectors are used for such applications. These technologies are appropriate for applications where direct solar radiation is high. The mechanism of conversion of solar to electricity is fundamentally similar to the traditional thermal power plants except use of solar energy as source of heat. In the basic process of conversion of solar into heat energy, an incident solar irradiance is collected and concentrated by concentrating solar collectors or mirrors, and generated heat is used to heat the thermic fluids such as heat transfer oils, air or water/steam, depending on the plant design, acts as heat carrier and/or as storage media. The hot thermic fluid is used to generated steam or hot gases, which are then used to operate a heat engine. In these systems, the efficiency of the collector reduces marginally as its operating temperature increases, whereas the efficiency of the heat engine increases with the increase in its operating temperature.

A. Concentrating Solar Collectors

Solar collectors are used to produce heat from solar radiation. High temperature solar energy collectors are basically of three types;

a) *Parabolic trough system:* at the receiver can reach 400°C and produce steam for generating electricity.

b) *Power tower system:* The reflected rays of the sun are always aimed at the receiver, where temperatures well above 1000°C can be reached.

c) *Parabolic dish systems:* Parabolic dish systems can reach 1000°C at the receiver, and achieve the highest efficiencies for converting solar energy to electricity.

B. Power Tower System

Solar thermal power uses direct sunlight, so it must be sited in regions with high direct solar radiation. Among the most promising areas of the world are the South-Western United States, Central and South America, North and Southern Africa, the Mediterranean countries of Europe, the Middle East, Iran, and the desert plains of India, Pakistan, the former Soviet Union, China and Australia. For all practical purposes, Solar Energy is inexhaustible. The yearly irradiation on total earth amounts to more than 1 billion terra watt hours. That is more than 60.000 times the global power demand [6]. By storing heat from solar radiation in storage tanks and hybridizing with fossil fuels solar plants are able to provide clean and reliable electricity throughout the day. This energy source is more evenly distributed in the Sunbelt of the world than wind or biomass, allowing for more site locations [7].

Solar power towers generate electric power from sunlight by focusing concentrated solar radiation on a tower-mounted heat exchanger (receiver) as shown in Fig. 2. The system uses hundreds to thousands of sun-tracking mirrors called heliostats to reflect the incident sunlight onto the receiver. The high accuracy 2 axis sun tracking that is required for projecting sun disk image onto the receiver is provided by a mechanical drive guided by a local control system. This local control system takes the responsibility of receiving sun position information

It is also in charge of detecting heliostat current position and comparing it to the required to attack the receiver at a pre-selected aiming point. As a result of the integration of optics, mechanics and control, the heliostat is ready to concentrate solar flux on the top of the tower[8].These plants are best suited for utility-scale applications in the 30 to 400 MWe range. In a molten-salt solar power tower, liquid salt at 290ºC (554ºF) is pumped from a 'cold' storage tank through the receiver where it is heated to 565ºC (1,049ºF) and then on to a 'hot' tank for storage. When power is needed from the plant, hot salt is pumped to a steam generating system that produces superheated steam for a conventional Rankine cycle turbine/generator system.

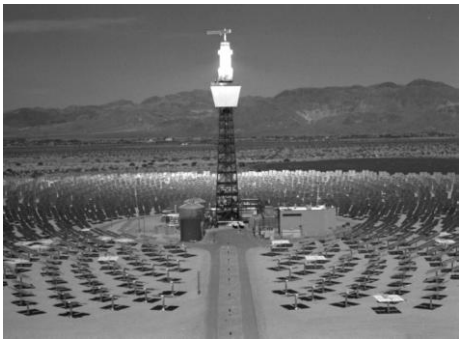

Fig. 1.The solar tower power plant Solar TWO (Barstow, California)

From a higher control level that calculates sun azimuth and elevation values employing high accuracy correlations.

From the steam generator, the salt is returned to the cold tank where it is stored and eventually reheated in the receiver. Solar thermal power plants typically require 1/4 to 1 square mile or more of land. One silver lining of global climate change and human impact on the land is that more and more farmland is becoming unsuitable for agricultural production. This land, presumably originally chosen for its sun exposure, begs to be used for solar thermal energy production. Utilization of desertification can prove to be a boon for solar thermal real estate procurement and growth. With solar thermal technologies being developed and advanced by companies such as eSolar, Brightsource, Abengoa, Acciona, Ausra and Schott Solar, the world has a new alternative. . Land use for years 2000 and beyond is based on systems studies [9, 10] It is investigated from the recent solar thermal plant that these take yet a huge amount of land.

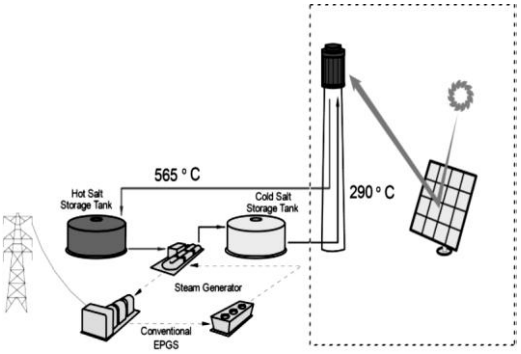

Fig. 2. Schematic drawing of a solar tower power plant with molten - salt technology.

One of the main tasks in the conversion of solar energy into electricity by solar power plants is to work out an optimized plant design. In this type of plant, the energy collector subsystems (heliostats, field, and receivers) represent a very important part of the cost break-down structure. Therefore, the use of detailed computer programs is of great interest in order to optimize the plant design. The two main conceptual ingredients for a solar plant optimization code are:

1. Reduction of the plant design to the value of certain design variables.
2. An optimization criterion: This means having a function that computes the objective quantity (i.e. total annual power output, cost per produced power, etc.) as a function of the design variables. In general we will use the cost of the energy produced by the plant as the optimization criterion, and therefore use the terms optimize and minimize as interchangeable [11].

C. *The Significance Solar Thermal Power Plants for Energy Policy*

Solar thermal power plants have been barely considered by a wider public until a few years ago. This is all the more surprising since they not only offer the promise of relatively low power costs (under mass production), but also have a notable advantage over other large - scale energy technologies: owing to their rather simple structure, consisting of conventional, straightforward components such as mirrors, systems of piping, insulated containers, and steam power plant blocks, they could be produced in large numbers within a fairly short time. If the necessary preconditions for such a rapid implementation were met, the whole "energy turnaround" including the development program could be completed within 15 – 20 years [9]. For solar power plants, several aspects are important which distinguish them *fundamentally* from conventional power plants. These will be discussed here using the example of solar tower power plants:

a) The simplest technology (the solar field)

This applies in particular to the mirror systems, the main cost item of solar power plants. For solar tower power plants, these are the *heliostats*. The consequence of their technical simplicity is that their development can be carried out very rapidly. It is indeed true that the heliostat field of a solar tower power plant is exceedingly large. However, since this field is completely modular – consisting of many simple, identical

structural elements – we can see that "large size and high cost" are by no means synonymous with "great development effort."

b) Construction from mass - produced components

This has the consequence that the development tasks (regarding the solar field) can be concentrated more strongly on production aspects than on the technology of the heliostats themselves. The reliable predictability of mass – production costs is here an important – and for power - plant construction unique – element of the required research and development.

c) Mainly conventional technology for the remaining power - plant components

A solar power plant has a completely conventional *electric power generating system* (power block), as in a coal - fired power plant. The *heat - storage system* also consists simply of insulated containers filled with molten salt. This salt is a mixture of sodium and potassium nitrates, two materials which have been produced by the fertilizer industry in large quantities for many years Therefore, the *heat - transfer circuit (molten - salt circuit)* of a tower power plant is in fact nothing new. The salt piping, the pumps, the associated control facilities, the construction materials, etc. need only to be optimized for the application at hand.

d) Separate development of the components is possible

In contrast to other power plants, solar power plants involve a relatively simple technology even for the parts outside the mirror field. A similar conclusion holds for the interactions of these plant components with each other and with the mirror field. There is no complex overall process (such as in particular in a nuclear power plant with its many safety systems, redundancy of components, and the associated intricate control facilities), but rather the individual subsystems (mirror field, tower circuits, heat - storage systems, molten - salt piping, steam circuit with its cooling system) are essentially simply connected in series, without complex feedback effects. The result is that the individual components of the plant can be operated during the developmental phase essentially independently, that is, they can be developed and tested individually. For this purpose, only certain ancillary facilities are required, which replace the remaining power - plant components for the purposes of operational testing. One requires no solar field and no receiver to perfect all these components; instead, the molten salt can be heated using a *gas - fired* test facility.

e) The interdisciplinary character of the development program

Development of solar energy cannot be limited – in contrast to the development of nuclear or coal - fired plants – to a particular special subject area. Nearly all the topics for research require a broad - based, interdisciplinary approach. By this, we mean that only a very small portion of the tasks lies within the field of development of solar technology in the narrow sense. Most of the tasks are situated in other areas; an example is the determination of the costs for mass production of the heliostats.

D. Assessment of Solar Towe Plant Potential in Bangladesh

Renewable energy potentials are classified into different categories, namely theoretical potential, available potential, technical potential and economic potential [15]. The GeoSpatial Toolkit provides the solar map of Bangladesh and it shows that the solar radiation is in the range of 4–5 kWh/m2/ day on about 94% of Bangladesh. Data on monthly solar radiation (Fig. 3) were taken from NASA SSE for 14 widely distributed locations in Bangladesh using the Hybrid System Optimization Model for Electric Renewables (HOMER) software [16].

Here we consider the findings of a number of studies regarding solar PV to anticipate the potential of solar tower power plant as it is beyond the scope of this study to provide data in connection of Solar thermal plant due to lack of availability. The average annual power density of solar radiation is typically in the range of 100–300 W/m^2. Thus, with a solar tower efficiency of 10%, an area of 3–10 km^2 is required to establish an average electricity output of 100 MW, which is about 10% of a large coal or nuclear power plant [17]. Unlike other energy conversion technologies, solar energy technologies cause neither noise, nor pollution; hence they are often installed near consumers to reduce construction costs. Thus, identification of suitable locations for application of solar energy is practically the search for suitable rooftops and unused land. A study suggested that 6.8% (10,000 km^2) of Bangladesh's total land is necessary for power generation from solar PV to meet electricity demand of 3000 kWh/ capita/year [18]. Another study found that total household roofs area is about 4670 km^2 [19] which is about 3.2% of total land area of the country. In urban area (Dhaka city) 7.86% of total land is suitable for solar PV electricity generation [20].

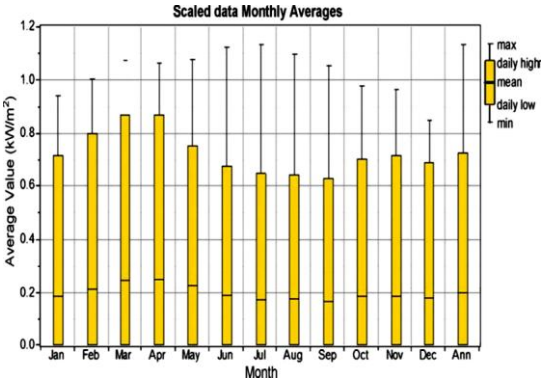

Fig. 3. Monthly average solar radiation in Bangladesh

BARRIERS

Solar thermal power plants need detailed feasibility study and technology identification along with proper solar radiation resource assessment. The current status of international technology and its availability and financial and commercial feasibility in the context of Bangladesh is not clear, therefore, it is still at an embryonic stage. There are plenty of barriers obstructing the widespread deployment of solar Tower plant. Different types of barriers experienced from the past are described below.

A. Policy barriers

- Lack of legal, regulatory and policy framework for market oriented
- Renewable energy based provision of modern energy services is dealt with by various ministries, agencies and institutions.
- Lengthy and difficult process for permission.

B. Technical barriers

- Lack of standards and quality control for solar tower power plant (STP) equipment.
- Local manufacturing and/or assembly of solar tower power plant components are currently very limited.
- Limited technical capacity to design, install, operate, manage and maintain STP based modern energy services, mainly as a result of lack of past activities in this new field.

C. Market barriers

- Limited knowledge on the STP market potential.
- Market distortions by subsidies or grant-based hardware installation programs.
- Government budgets for subsidizing renewable energy (RE) projects are limited as the demand for financing the various national priority areas (health, education, disaster management, etc.) is great.

D. Economic, financial and financing barriers

- High initial capital costs.
- Financial institution biases and unfamiliarity with financing STP projects.

E. Information barriers

- Lack of information about STP resources, technical information, and equipment suppliers
- Lack of awareness of STP in public, industry, utility, financial institutions and policy-makers.
- Little empirical knowledge on the costs and benefits of the range of technologies available for providing STP based modern energy services exists.

F. Human resource barriers

- Limited expertise in business management and marketing skills.
- Limited in country capacity for STP data collection and analysis.
- Lack of expertise and services in system design, installation, operation and maintenance of renewable energy technologies.

CONCLUSION

Bangladesh Government has a vision to electrify entire country by the end of year 2020. Resource assessment, technological aptness and economic feasibility are the basic requirement of project evaluation. The solar radiation is available sufficiently over the country. The solar tower power and point focusing dish type plants are popular worldwide. The solar energy based power generating systems can play a major role towards the fulfillment of energy requirements of industry. Appropriate decision and financial aid from the government and NGOs will be the cornerstone of the solar tower power plant in Bangladesh.

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ID 38 **A3-08**

Innovation in Climate Change Adaptation: Examples from Northern Bangladesh

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ABSTRACT

Impacts of climate change are so intense that traditional knowledge, which the rural communities have been using for centuries in adapting to environmental change, is not enough to fully secure livelihood of the affected community. Innovation, thus, requires both in knowledge and practice to face the challenges of climate change. By definition, all innovation must contain a degree of novelty. However, it is not just the invention of a new idea, but covert idea into practice and developing comprehensive methodology to achieve certain goals. Taking into account the observed and potential impacts of climate change on agriculture and resultant food insecurity, the RESOLVE has introduced two innovative agriculture practices in Northern district of Gaibandha and Sirajgonj based on local agro-climatic factors targeting specific needs of specified groups of people.

INTRODUCTION

Since the dawn of civilization, human has been adapting to environmental change for their survival. In the course of time, various technological and non-technological innovations have helped to shape and form current anthropocene. However, much has been loss to reach the current state, particularly causing irreversible modifications in the nature. Consequently, humanity has been facing revenge of nature in the form of increased frequency of natural disasters. For many no alternative remains unless adapting to this climate change. Therefore, both the policy makers and academics are recognizing climate change as the most significant environmental, economic and security threat that humanity facing.

Continuous search and research is going on developing and promoting innovative ways to respond to climate change. However, poor communities of developing countries mostly rely on traditional knowledge to find adaptive solutions to climate change. This is partly due to inaccessibility to advanced technological solutions and largely their time tested first-hand accumulated knowledge that they have gained over time with adapting to environmental change. Now there is a need for information on specific examples or case studies illustrating how these innovations can be implemented in the real world. This report purports to do just that by highlighting some specific examples of how innovation is being implemented, focusing climate affected villages of Bangladesh.

Innovation is to take advantages of new ideas leading to the creation of a new method, idea, product, service, etc. By definition, all innovation must contain a degree of novelty. However, it is not just the invention of a new idea, but covert idea into practice and developing comprehensive methodology to achieve certain goals. The Oslo Manual distinguishes three types of novelty: an innovation can be new to the firm, new to the market or new to the world. The first concept covers the diffusion of an existing innovation to a firm – the innovation may have already been implemented by other firms, but it is new to the firm. Innovations are new to the market when the firm is the first to introduce the innovation on its market. An innovation is new to the world when the firm is the first to introduce the innovation for all markets and industries [1]. This paper will present two innovative livelihood practices of rural Bangladesh, which may not be totally new practice but reformulated to adjust with local context.

INNOVATION IN ADAPTATION

Innovation can occur in any sector of the economy and society, including government services such as health or education or social services such as disaster volunteering. In case of innovation in adaptation, innovation means different activities practicing by the human to make the world safe, from present and upcoming shocks and surprises, particularly climatic shocks. Being one of the worst victims of climate change, Bangladesh's development has been repeatedly obstructed by floods, riverbank erosion, drought, salinity, cyclone, cold wave etc. Agricultural productions are being hampered differently for different climate change impacts and causing food insecurity for the poor. Innovation is thus essential if countries and communities are to recover from the climatic shocks.

Agriculture is one of the most affected sectors from climate change, where both direct and indirect loss incurred. Direct loss mainly occurs when different natural hazards destroy agriculture production and indirect loss is related to reduced production due to changing different parameters of climate like rainfall, temperature etc. Introducing innovative climate resilient practices for promoting sustainable agricultural and secured livelihood is very much essential for the people who are more vulnerable from climate change. With the aim of making rural communities more resilient towards adverse impacts of climate change and to increase food security the RESOLVE (Regenerative Agriculture and Sustainable Livelihoods for Vulnerable Ecosystems) is being implemented in the Northern and Central part of Bangladesh. The paper presents outcomes of some of the interventions targeted in improving livelihood of the rural poor in response to climate change.

METHODOLOGY

The study employs qualitative approaches to describe the process of intervention. Basically the RESOLVE is an on-going action research project and it is too early to have a final output. The study therefore did not attempt to draw any conclusion, rather based on two FGDs in three projects areas and observation, tries to make a rationale of introducing these innovative practices and their acceptance to the project beneficiaries.

INNOVATIONS AT RESOLVE FIELD

Sustainable management of land and water resources for intensification of agriculture and poverty reduction in many developing regions has remained one of the most challenging policy issues for a long time. Due to climate change the agro-ecosystems have been degrading more abruptly than before that gradually deprives the poor of key productive resources and affects communities whose livelihoods heavily rely on utilization of these resources. Degradation of land and water resources gradually diminishes the capacity of individual farmers and communities to undertake critical investments needed to reverse the situation. This in turn reduces opportunities for addressing nutritional and other necessities and depletes the ability to buffer shocks, thereby increasing vulnerability of livelihoods [2].

Taking into account the observed and potential impacts of climate change on agriculture and resultant food insecurity, the

RESOLVE has introduced two innovative agriculture practices for Northern District of Gaibandha and Sirajgonj. The interventions were designed based on local agro-climatic factors targeting specific needs of specified groups of people. For instance, in Gaibandha, a water scare area, Integrated Fish-Duck- Vegetable introduced to optimize water use and increased protein and vegetable supply for the poor communities using their tiny land who otherwise unable to afford their minimum nutritional requirement.; In Siragonj RESOLVE has introduced Compartmental Homestead Poultry to increase protein supply for the communities of Remote Island who usually take protein rarely once in a month and suffer from acute malnutrition.

A. Integrated Fish-Duck-Vegetable Cultivation (Gaibandha)

The RESOLVE has targeted to transform landless or small holders farmers of Gaibandha into dual economic agents engaging simultaneously in the production and consumption of the same commodities and investments in improving productivity and sustainability of natural resources. Hence, smallholder farmers could be referred as farm-households. Right holders at Gaibandha are characterized by small land ownerships or no lands, mostly engaged in sharecropping. With the aim of increasing income within limited homestead area, Integrated Fish-Duck-Vegetable cultivation introduced in Gaibandha where a 15 feet long and 7 feet wide pond developed for fish cultivation, the whole pond was covered with small net to protect the small fish from duck, at the dyke of pond seasonal vegetables were grown. The water for pond comes from a tube-well through a pipe, where women can supply water easily by hand pumping only half an hour every day in dry season; in rainy season the pond receives pond from rain. Another advantage of watering everyday by tube-well is it helps mixing oxygen is water that is essential for fish growth. Along with training on different components such as fish culture, duck rearing and vegetable production, RESOLVE has been providing right holders with quality seeds, improved variety of duck and fish seeds. Moreover, a tubewell has been provided and erected which serves drinking water and water for fish culture in dry season (Fig. 1).

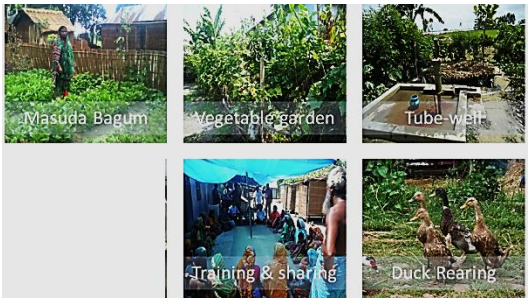

Fig. 1. Different component of Integrated fish-duck-vegetable cultivation at Gaibandha

In addition, RESOLVE is providing all kinds of technical supports such as how to use land properly, how to manage water, how to produce organic fertilizer by managing different kinds of wastes and how to market additional products to. It seems right holders' income has increased by practicing Integrated Fish-Duck and Vegetable along with increasing nutritious food consumption which implies that they are more resilient to climate change in case of livelihood options.

B. Compartmental Poultry at Homestead Area (Sirajganj)

Most of the right holders under RESOLVE are living in remote river island of Sirajganj who are landless poor, small and marginal landowner and about 75 percent of them are engaged in agriculture either as wage labourer or sharecropper. However, most of them are struggling to fulfill their household's food and other basic demands. Moreover, due to climate change their survival becomes harder.

As most of the households are poor and marginal farmer, in case of any climatic impacts they lose their limited livelihood options and fall into deeper vulnerability. Being located in remote river island, those people remain detached from mainland for the whole rainy season. In that time, they have to rely on their own production for survival. Moreover, their income opportunity reduces drastically. To address the challenges and also to find a sustainable solution, RESOLVE has introduced compartmental poultry in Island of Sirajgonj. Poultry rearing is a traditional practice at households in rural Bangladesh. Mostly, women are engaged with the activity besides other household activities. Here RESOLVE slightly modified the traditional practice by introducing compartmental poultry cage. In each cage there would be four compartments, where in one compartment the mother poultry stays. They are transferred to another chamber when they started hatching eggs (Fig. 2).

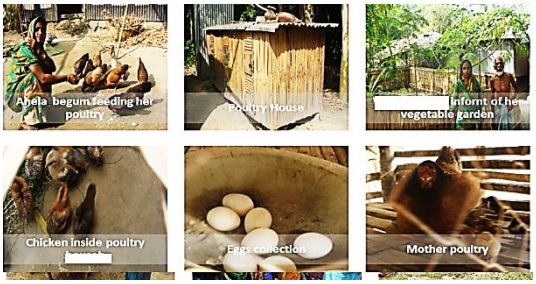

Fig. 2. Different components of Compartmental poultry farming at Sirajgonj

As soon as they complete hatching, they again return to their original compartment and the eggs are used for consuming or selling. Some of the eggs are stored for breeding in another compartment. Through this separation of mother poultry from egg they become started hatching egg within short time than the normal interval period. A poultry cage occupies very small amount of area, even can be managed within household. Moreover, using this technique the household can easily increase their income three times that traditional chick rearing.

ACKNOWLEDGEMENT

The Authors acknowledge financial contribution from Oxfam Novib to implement the RESOLVE project. Support from GUK (Gana Unnayan Kendra) and GKS (Gana Kallayn Sangstha), who are also gratefully acknowledged, who are implanting the project at field level.

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ID P8 **A3-09**

eSebaPass: A Wallet for the Farmers for Living Green

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ABSTRACT

In Bangladesh, most of the rural families possess a fallow land in their homestead. Some female farmers partly produce vegetables in their homestead for their own consumption and/or for generating extra income. This fallow land can be effectively utilized to produce more vegetables if the female farmers can find a link with a direct tangible financial benefit. In this work, we introduce a traditional village vendor, we call it "e-Village Vendor" with an e-wallet, we call it "eSebaPass" for a safe and reliable financial transaction. We carried out a survey in a village in Bangladesh to measure the underutilized land area and to reconfirm the missing link to motivate the farmers to produce vegetables in their homestead. We introduce the concept of e-village vendor, an entity to buy produces from one door and sell them to the other. The financial transaction will be done by our developed "eSebaPass" system. We also discuss how our eSebaPass can bring social, economical and environmental benefits by encouraging the masses to grow green vegetables.

INTRODUCTION

We have reconfirmed the following fact from our recent survey carried out in a village in Bangladesh- production around the homestead can be an effective means for ensuring food and nutrition security in the rural areas. The marginal farmers and agricultural labors become jobless in-between/ after the cultivation and harvesting seasons. During this period, they go through a serious financial constraint which results malnutrition among the children and women. An alternative income source is necessary to support them to get rid of this financial stress. Our survey shows that 74% of the farmers do have underutilized fallow land and they have their time to spend to produce dairy products, vegetables and fruits. A portion of the farmers (78%) are involved in selling the produces to earn an extra income. However, this is not a popular case yet. There are few challenges for the farmers- the amount they grow are small, therefore marketing those products are difficult and the payment is not guaranteed. The farmers need to be motivated with immediate benefits.

In the last two decades international NGOs such as Helen Keller International (HKI), CARE Bangladesh, etc. and agricultural extension department of the Bangladesh government have carried out number of projects in different parts of the country to assess the impacts of the homestead gardening. As a result of these extensive activities from the government and non-government organizations homestead garden gained popularity. The findings of these activities are- (1) the average intake of leafy vegetables in the family increased significantly during the projects period in the respective areas; (2) diseases due to vitamin deficiency e.g. night blindness is also reduced significantly; (3) villagers also earned money from the produces around the homestead [1].

In this work, in order to solve the "payment guarantee" and "marketing small amount of products" we introduce "e-Village Vendor" with an e-wallet, we call it "eSebaPass" for a safe and reliable financial transaction. We carried out the survey to measure the underutilized land area and to reconfirm the missing link to motivate the farmers to produce vegetables in their homestead. The survey data reflects that although every village homestead has a garden, the villagers are not taking advantages of the potentiality. We introduce the concept of e-Village Vendor, an entity to buy produces from one door and sell those to the other. The financial transaction will be done by our developed "eSebaPass" system. We also discuss how our eSebaPass can bring social, economical and environmental benefits by encouraging the masses to grow green vegetables. In second part of this paper we explain the scope of homestead garden. In the third part, we analyzed the survey results to identify the missing link to harness more benefits from homestead gardening. In the forth part we proposed a business model to put an extra motivation to this activity, its social impact. Finally the conclusion and future works.

HOMESTEAD GARDENING

Homestead gardens are the cropping of vegetables, fruits, trees and condiments. These produces serve as the supplementary sources of nutrition and income. This cropping is usually done in the homestead but it can be in the land nearby the homestead that is not used for commercial farming. Different techniques of plantation are invented and are suitable in different geographical and environmental conditions. Like in flood and desert prone areas gardening or plantation in container is more effective. In some definitions the plantation/cropping in the container, along fields, strips of the rail track, highway and canals are also considered as homestead garden.

The purpose of the garden cannot be commercial. The produces can be sold partially after fulfilling the domestic need. Crop diversity within a small piece of land is another characteristic of these gardens. Different crop supplements different vitamin or mineral and can supplement the family need. The types of the crops/plants vary from country to country. Typical homestead garden in Bangladesh contains vegetables, herbs, and mixture of annual and perennial trees.

INCOME OPPORTUNITY FROM HOMESTEAD GARDENING

We conducted a questionnaire survey in Chor Durlov Khan Village of Barishabo Union, of Kapashia Upazila of Gazipur district, a remote village with minimum infrastructural facilities. 100 respondents were randomly picked and uniformly distributed among different economic classes of the village. The survey results can be analyzed as follows:

1. Homestead gardening is very popular among the villagers. 97% of the villagers possess a garden in their homestead. Villagers plant mostly indigenous leafy, vitamin-enriched vegetables. Some households possess annual and perennial fruit trees. Besides most of them raise chicken/duck as well.
2. Present use of land for gardening and livestock rearing is very low. On an average only 31.15% of the available land is used for this purpose. In a rural homestead, a significant amount of land is required to be used during harvesting season for processing the commercial harvest. Still the amount of unused land is more compared to necessity. Villagers involved in agriculture labor, day labor etc. do not need homestead for harvesting purpose. Moreover villager can plant in containers etc. that allow moving the plants in case of necessity. Considering the above facts, the use of land for gardening is significantly low.
3. 78% of the villagers responded that they have excess of produce at some point of time. Although they buy

vegetables almost all times. Only one of them gives it to the neighbor and the rest sell those in the market. To sell in the market, the quantity must be significant like few KGs. Selling one egg or few hundred grams of vegetables or fruit in the market is not economically justified. The villagers sell the produces of the homestead in case of excess production as well as at the time of need; like when they don't have income. Selling in the market is well acceptable to the society. Among those 78 families who have excess produces at different times, 73 families the man of the house sell those in the market.

A point to be noted that although selling the home produces in the market is part of the culture, but selling it to the neighbor is very rare. It is possible to sell small units to the neighbors on the contrary only large quantity is possible to sell in the market. Possibly the buyer as well as the seller is not aware of each other's demand.

4. On an average each family earns 273 taka per month from its homestead produces. The income varies from 83 taka to 600 taka per month for different families. 50% of the respondents mentioned that because of absence of convenient way of selling the produces and due to lack of working people for production in the family, villagers are not being able to increase the production by utilizing more land. Only 2% of the responders mentioned that they would not increase the production even if somebody comes and buy the goods in any small quantity on a regular basis. Here the point to be noted is vegetable plantation and livestock rising in the homestead do not demand extensive involvement. The female and senior members of the family can handle it comfortably. Which indicates that the return from gardening cannot provide sufficient incentive.
5. In case of urgent need, buying from the neighbors is a very rare practice. In 98% case they usually need to travel to a distance to buy from village shop and Bazar. Occasionally some of them do buy or exchange from the neighbors. The cost of items bought from some place other than the shops and Bazar is higher and quality is not good.

A. Missing Link:

From the above analysis following points could be concluded:

1. Villagers understand the fact that more production in the homestead garden means increased financial comfort and nutrition. Necessary fallow land exists, high quality & high yield seed is available in the market and various techniques related to plantation in different areas and in different seasons are also available from the local agricultural extension office. Moreover, female and senior members of the family can spare the necessary time in this regard. Most importantly the whole activity can be performed without any significant investment. Still entire available land is not being used or the technologies available in the local support centers are not being adopted by the villagers to increase production. According to the survey, the reason behind this is uncertainty of selling the produces. e-Village Vendor can meet the gap of buying the excess produces in small amount on a daily basis. Since the e-Village Vendor is doing the buying & selling business throughout the village, he is well aware of the production and demand of all villagers. Hence can advice about the salability of different produces.
2. There are two different situations when the villagers need to sell the produces. In the first case they have a small amount of vegetable or fruit that they want to sell. The amount is not enough to go to the market and spend few hours for selling. But it might be enough for a family that need such item. In this case buyer and seller are not aware of each other's demand. So both miss the opportunity. In the second case the seller have enough produces to sell. In that case spending few hours of time in the market to sell the produces are worth enough for the seller. On the other hand, the villagers need some small amount of different items on a regular basis. May be some of their neighbors are willing to sell the same. Due to unavailability of the information the buyer travel to distant place to buy from a shop. In the first case the e-Village Vendor may appear as the matchmaker to both buyer and seller.

E-VILLAGE VENDOR

e-Village Vendor is a local residence known and trusted to the villagers. He carries the selling items in the box carrier of his bicycle and an IC card reader/writer to perform financial transaction with the villagers. The e-Village Vendor consistently maintains a credit limit of eMoney in the system from the smart center so that he can execute his business smoothly. The villagers who want to participate in this process collect eSebaPass from the Smart Center. eSebaPass is an IC card which among other services offers eMoney service. The villagers can perform secured financial transaction using this system. They can also load and spend eMoney with the e-Village Vendor. The e-Village Vendor visits the villagers' homestead to enquire whether they have anything to sell or buy. While buying from the villagers the e-Village Vendor gives a value approximately 30% lower than the selling price of the same item. The value is loaded into the eSebaPass as eMoney. No cash transaction.

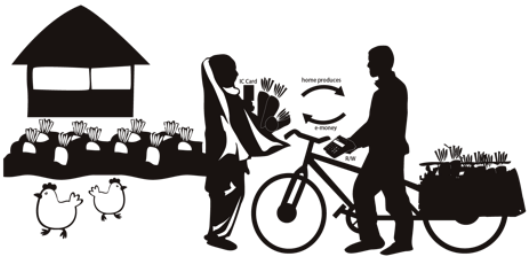

Fig. 1. Buying from the villagers

This helps the both party to have exact value without maintaining any coin. The use of eMoney also helps the e-Village Vendor to startup the activity without any cash investment. In this regard the e-Village Vendor updates his price list with the corresponding price in the local market on a regular basis. The e-Village Vendor uses a pre-fixed buying and selling price for every item. So that he can avoid any prospective dispute among the villagers. If the villager is interested to buy any item from the e-Village Vendor, then also she pays price of the item in eMoney stored into her eSebaPass. From the morning he visits different houses in the village to buy and sell home produces. The Items could be vegetable, chicken/duck egg, fruits etc.

Fig. 2. Selling to the villagers

B. eSebaPass & Related System:

eSebaPass is an multipurpose IC card which can offer different services sharing the same platform. The simple reader/writer used for the transaction is a cost effective means of service delivery. It is a low cost microcontroller based device possessing an inbuilt audio system. So it is possible to program the reader/writer to store the item names along with buying and selling price. The audio system confirms the transaction values to the cardholder and save the cost and hazard of printing receipts in a dusty humid climatic condition of rural Bangladesh. The reader/writer can work in both online and offline mode. Once the battery is fully charged it can perform one thousand transactions. The transaction data can be uploaded to the server periodically from the smart center.

Fig. 3. Simple Reader-Writer & eSebaPass

C. Social, Economical, Environmental Benefit of eSebaPass

People in the rural areas always bear the risk of possessing physical cash. Because of inadequate available financial service, they keep the physical cash in their home, which can be stolen. Before and after transaction they carry the cash and bear the risk of robbery. Even they used to save money in the home, which can be misappropriated by the neighbor or family members. But within the existing socio economic conditions prevail in Bangladesh, it is not possible to make the financial services available to the remote part of the country. The existing eMoney systems offered by the Banks are also not feasible for the small value transactions of 10 or 20 taka. In the backdrop of this situation we introduced eSebaPass. It is a multi service platform. Multiple service providers can offer their own services using this platform. Hence infrastructural overhead is shared by all service providers. This is suitable for small transaction values as well. We hope that eSebaPass platform would be able to offer banking services successfully up to the remotest part of the country, which will allow the villagers to receive savings, spending, remittance services using eMoney and eliminate the risk of possessing physical cash. Besides that many more ICT based services can be offered to the villagers.

It is expected that this new money system will able to attract a portion of cash transaction in the rural areas. So less cash will be used in the villages. This will reduce the money management cost for the central bank due to less requirement of printing currency notes. Hence saving environment.

D. Financial Viability:

On an average 300 families live in a village. A rural family spends around 2 thousand taka every month for purchasing food. Assuming 5% of the consumption is done through our proposed system then the transaction volume of an e-Village Vendor is 30 thousand taka every month. If the difference between buying and selling price is 30% then the net income of the e-Village Vendor is 9 thousand taka per month.

CONCLUSIONS

In this work, we proposed an "eSebaPass" system to facilitate a safe and secure financial transaction system which will ultimately motivate the villagers to engage themselves in income generating activities. We carried out a survey to assess the underutilized land area that can be used for growing vegetables by themselves. It is also identified that the farmers would be willing to grow products if the payment system is guaranteed. The "e-Village Vendor" a traditional village vendor with advanced technology visit the doors of the farmers to buy fresh produces from one door and then sell them to another with real-time payment benefits. This income generating program can motivate millions of farmers to grow green vegetables which will ultimately bring social, economical and environmental benefits to the globe. There are risks that the fresh produces will have expiry date and the e-Village Vendor will be in risk when the products are not sold. An effective producer-consumer information management mechanism will be required.

FUTURE WORKS

In our business model for his survival, the e-Village Vendor need produces to buy from the villagers. So he will encourage the villagers for more production so that he can buy from them to sell it to other villagers. On the other hand the villagers will receive money. So this financial benefit will work as continuous motivation for all. After some time the e-Village Vendor would became an expert regarding the future demand and he can predict accurately about over or under production of any specific item.

In coming days we will continue the activity of the e-Village Vendor to observe:

1. The financial sustainability of the e-Village Vendor.
2. Increase in family income form the produces from the homestead.
3. Increase of per capita vegetable intake.
4. Acceptance level of eMoney by the rural people.

Eventually we will refine the business model so that it can be replicated to other villages. Hence the whole country can enjoy the benefit.

Familiarity of eMoney to the rural people will allow us to introduce different ICT based services like eCommerce to the rural population. Moreover eMoney will give security against theft and robbery. In the national perspective, the more money being transacted through eMoney, would incur more savings from currency management cost of the central bank.

ACKNOWLEDGMENT

The Smart Center project was funded by METI, Japan and System LSI Research Center, Kyushu University, Japan. ASA, Bangladesh extended logistic support. The survey was funded by Smart Center Project.

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ID P7 **A3-10**

Integrating Engineering data with geophysics in Carbon sequestration: toward reliable estimation of CO2 saturation in Soil of Bangladesh

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ABSTRACT
The purpose of this paper is to highlight how integrating the knowledge about engineering data (wettability, relative permeability, pressure etc) with geophysical technique can reduce many ambiguities and help geophysicists to obtain a more accurate and reliable results in estimating CO2 saturation in Soil of Bangladesh. An overview of some techniques in estimating the saturation will be given including RST, but the paper will focus on seismic since it can provide estimate of saturation over the whole storage area. Several issues and ambiguities regarding seismic monitoring of saturation in carbon sequestration will be discussed along with how integrating engineering data can be useful in that perspective.

INTRODUCTION

Carbon sequestration is considered to be one of the important contributors to the potential solutions of the global warming problem by reducing the amount of CO2 emissions. However, there are several issues related to this technology that are still under discussion and development. One of the most important aspects related to the carbon sequestration is monitoring the CO2 plume in the subsurface as it develops. By doing so, the extent and saturation of the CO2 can be estimated and monitored. However, integrating engineering data and knowledge can help reducing many uncertainties and ambiguities related to the CO2 monitoring process so that more reliable results can be obtained. This paper was inspired by observing that in some geophysical studies in soil of Bangladesh, time lapse seismic was used to estimate the CO2 saturation in carbon sequestration project but the results indicate saturations that violate what the engineering data (such as relative permeability and fractional) suggests regarding the maximum possible CO2.

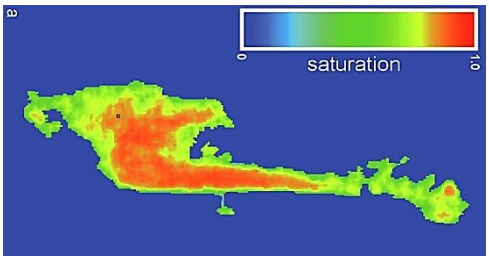

Fig. 1. Top most CO2 layer derived based on time- lapse seismic in Sleipner project, the color highlights CO_2 saturation. Notice, that that saturation was estimated to exceed 0.9 in many locations [1].

METHODOLOGY

A. Techniqes for Estimating Carbon Dioxide Saturation

A.1. RST

This reservoir saturation tool uses the pulsed neutron capture to determine changes in saturations when brine is displaced by CO2 in saline aquifers [2]. The parameter collected by this tool is derived from the rate of capturing thermal neutrons which comes mainly from chlorine (rich in water). As CO2 displaces brine, the capturing rate of thermal neutrons decreases which allows estimation of water saturation (and hence CO2 saturation) [2]. Therefore, it is very useful to use a method that gives information about changes over the whole area, which can be achieved by seismic. There are other well logging tools that can be used (such as density and neutron porosity) but they can be used more to have qualitative analysis rather than quantitative estimation of saturation.

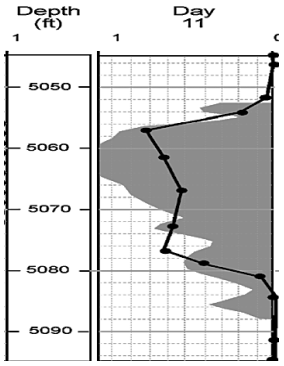

Fig. 2. CO2 saturation at injection well, note how different it is compared to observation well at day10 and 29.

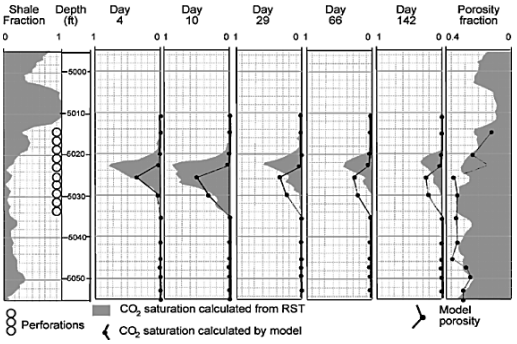

Fig. 3. CO2 saturation at the observation well calculated from RST, the injection stopped at day 10. We can notice how the saturation increases with injection and then started to decrease as the injection stopped and the plume started to develop. Note that saturation calculated in this case represents the zone very close to the pore hole.

A.2 Time-lapse Seismic

This method includes both cross well seismic and seismic survey conducted at the surface. It technique has been used widely in monitoring CO2 plume development over the sequestration area [1, 3, 4]. Time lapse seismic could be the best method to monitor the extent of the CO2 plume in a qualitative way (to monitor where the CO2 is going in the overall large picture). However, the quantitative conversion of velocity changes to saturation changes requires a rock physics model [5]. Such model describes the relation between changes in acoustic velocity and fluid substitution (changes in saturation). The paper will highlight how the knowledge about some engineering data can help to have better and more accurate use of rock physics models to estimate the CO2 saturation based on time-lapse seismic.

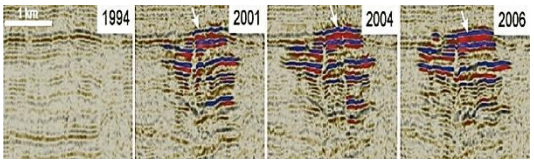

Fig. 4. seismic images of Sleipner plume showing its development, the white arrow refers to the top most CO2 layer. We can notice the lateral and vertical movement of CO2 within the storage.

B. Integrating Engineering Data with Geophysics to obtain more Accurate Estimation of Carbon Dioxide Saturation

As mentioned earlier, inverting velocity changes observed from seismic to obtain CO2 saturation depends mainly on pressure changes, rock and fluid properties, and style of saturation.

B.1 Pressure changes

Pore pressure and effective pressure in the storage will change as a result of injecting CO2. Such pressure changes (if were large) can induce changes in the acoustic velocities. That is, as CO2 replaces some water, the resultant compression velocity change will not be only a result fluid substitution but also pressure changes. Dependence of velocity on pressure can be estimated using lab measurement or theoretical models [5], but it is out of the scope of this paper. The question here is how to know the changes in pressure as result of CO2 injection and the answer can be obtained from the engineering data. Downhole pressure can be measured before and after injection which can be then used to obtain the pressure build up. Simulation can be used to get information about pressure changes over the whole storage area. If we would like to test the feasibility of monitoring (before injection), then the pressure build up can be estimated using multiphase extension of Darcy's law combined with the Buckly Leverett solution [6]. Once the pressure build up is known, then the corresponding change in velocity can be estimated. Such change in velocity should be removed from the total velocity change before proceeding with fluid saturation calculation.

B.2 Fluid and rock properties

The most common rock physics model used is Gassmann [5]. An input, that is needed to invert for the saturation of fluids, is the fluid properties (bulk modulus and density). Geophysicists often use Batzle and Wang model to find the bulk modulus of brine and CO2 separately at the reservoir pressure and temperature [7]. Although the supercritical CO2 is immiscible in water, a small portion (around 5%) will be dissolved as shown in Fig. 4 [8]. This chart gives the solubility in pure water and for brine it will be slightly smaller depending on its salinity [8]. The brine bulk modulus will decrease by about 0.3% when dissolved CO2 is included [5]. Since rock physics models assume no alteration in the rock frame due to fluid substitution, it is then important to model the geochemical effects and their impact on acoustic velocities (velocity decreases as porosity increases). This should be done before using rock physics model to invert for saturation. Fig. 5 [9] demonstrates how the change in porosity can affect the bulk modulus of the rock when CO2 replaces brine (compared with the case when porosity changes are not considered). From this figure, we can notice that for a given CO2 saturation, the rock bulk modulus can have different possible values depending on whether porosity and rock frame alteration have happened or not. Porosity enhancement will decrease the velocity.

Fluid sampling in the storage reservoir can give information about the changes in the fluids compositions and pH which can be used to infer geochemical changes in the rocks.

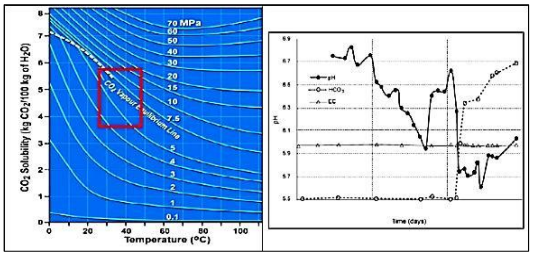

Fig. 5. chart of CO2 solubility in pure water, the red rectangular shows the usual pressure and temperature conditions for carbon sequestration [8].

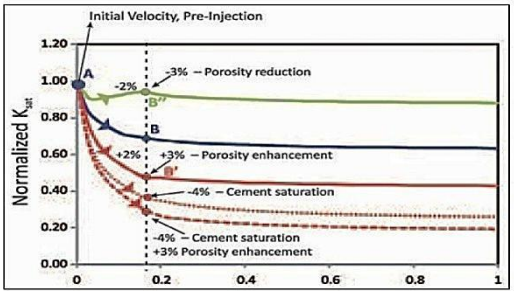

Fig. 6. Forward modeling of changes in bulk modulus of rocks upon CO2 injection (x-axis represents the CO_2 saturation). The vertical axis represents the bulk modulus normalized with respect to their pre-injection values. The blue line represents Gassmann prediction (no change in porosity), while red solid and dashed lines refer to situations where porosity increases (up to 3% increases) and cement dissolves (decreases by 4%). Uniform saturation was assumed [9].

B.3 Style of saturation

If both pressure and geochemical impacts were counted for in velocity changes, then the remaining velocity changes (and probably the largest) will be due to fluid substitution (CO2 replacing brine). CO2 has lower density and bulk modulus compared to brine and hence, the velocity will decrease when CO2 displaces the brine. The drop in compressional velocity (Vp) can be then inverted to CO2 saturation using a rock physics model. However, there is a significant ambiguity that this inversion suffer from, which is the nature (or style) of saturation. Two possible styles exist which are: uniform and patchy saturation. Fig. 7 demonstrates the two different styles of saturation. It is clear that, the classification of those styles is related to the scale of saturation. This can be characterized by critical diffusion length ($Lc= \sqrt{[k\ Kfl/f\ \mu]}$ where k is permeability, Kfl is the bulk modulus of the fluid substituting (CO2 in this case), f is the frequency of seismic (≈ 100 Hz) and μ is viscosity. If the patch size was larger than Lc, then we will have patchy saturation whereas uniform saturation happens when the size is less than Lc [5]. Different fluids will feel different pressure as the seismic wave goes through the rock.

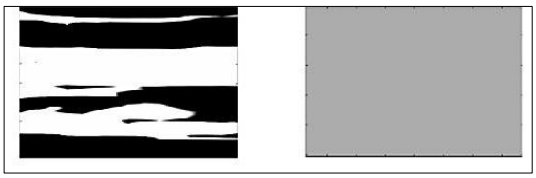

Fig. 7. An example of patchy distribution of oil and water (dark patch represents oil). Within each patch is a single phase. And next one is a uniform distribution of water and oil (very fine patches that the overall picture looks as we have one fluid) [10].

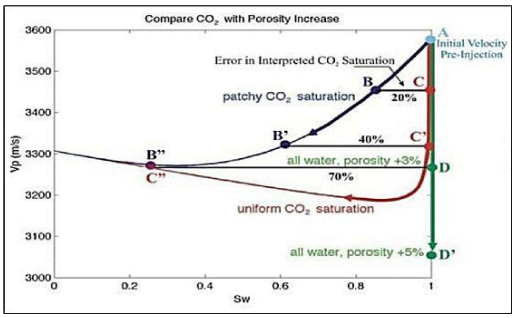

Fig. 8. Forward modeling of compressional velocity (Vp) of a rock during CO2 injection, x-axis is water saturation. Three scenarios are shown: uniform saturation without any geochemical effect (in red), patchy saturation (in blue), and porosity enhancement due to dissolution process with no fluid substitution (in green). Black horizontal bars refer to the difference in interpreted CO2 saturation [11].

Based on Fig. 9, we can notice the difference in seismic response between uniform and patchy saturation especially at CO2 saturation up to 40%. This can introduce an ambiguity when interpreting CO2 saturation from time-lapse seismic. For example, as shown in Fig. 8, an observed Vp decrease of 100 m/s will correspond to around 20% CO2 saturation (point B) velocities, observed from time-lapse seismic, to CO2 saturation.

B.3.1 Wettability and relative permeability

Reservoir formation rocks are water wet and hence, brine tends to attach itself to the solid surface more than CO2. Also, water mobility is much lower than that of CO2 which means that it will be difficult to displace all water. Fig. 8 shows an example [12] where the relative permeability to water becomes zero around 45% water saturation. This means that we will have at least 45% irreducible water that cannot move. Moreover, when plotting CO2 fractional flow rate versus CO2 saturation (data from [12]) as shown in Fig. 10, we can notice that the CO2 fractional flow rate is equal to one (zero water fractional flow rate) when CO2 occupies around 55% of the pore space. Principally, this experimental result from suggests that the CO2 cannot exceed 55% since the water fractional flow will be zero. This piece of information can be useful to constrain the inversion process to obtain CO2 saturation from velocity changes. If we were dealing with similar rock and the inversion result gives saturation much higher than 55% (especially away from the wells and after the injection stopped) , then some of the velocity changes might be related to some artifacts (noise...etc) or geochemical impacts that were not counted for. Moreover, for this formation rock, CO2 saturation is expected to be 40-45% on average in the sequestration site. Again, this can be used to constrain and validate the estimation of CO2 saturation from seismic.

The overall picture supports the patchy saturation too, as shown in Fig. 11 [3]. The velocity changes map shows patchy pattern in the overall picture. CO2 moves faster and easier in high permeability zones resulting in the non-homogeneous distribution of velocity changes observed in Fig. 10. This spatial variation in the rock properties can also explain the difference between saturation observed at injection and observation well. Fig. 11 demonstrates the presence of large patches but what about the saturation distribution inside each large patch, it is really uniform? Let us revisit the definition of critical diffusion length (Lc= √[k Kfl/f μ]), which characterizes the size of patch, above which saturation can be considered patchy and it will affect seismic response. We can notice that it depends on both rock and fluid properties. The presence of permeability anisotropy may result in having different Lc at different zones. Moreover, one may infer that permeability anisotropy may result in some preferential paths for the injected fluid and hence, more patchy behavior. The question is how to infer such heterogeneity and what scale are we talking about. According to Mavko et al. [5], Lc varies usually in reservoir rocks from 2 to 30 cm depending on fluid and rock properties. Therefore, such length might be observable at core scale and hence, uniform or patchy saturation might be noticed.

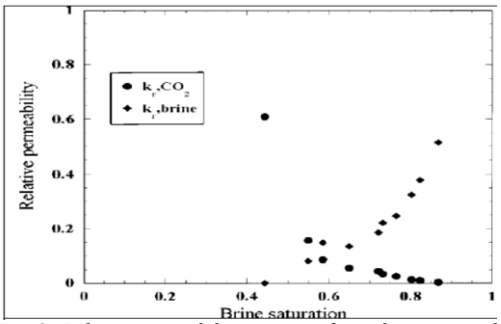

Fig. 9. Relative permeabiligy cureves from data measured duing drainage phase in a rock sample [12]. Note that the relative permeability of brine becomes zero at irreducible brine saturation of 45%

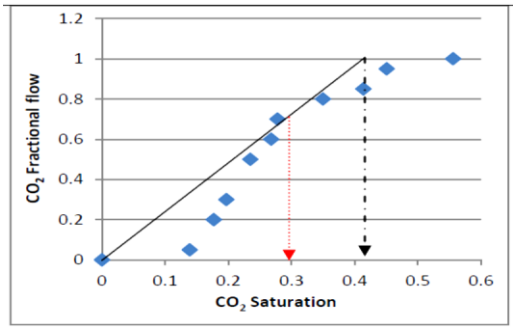

Fig. 10. Relative permeabiligy cureves from data measured duing drainage phase in a rock sample [12]. Note that the relative permeability of brine becomes zero at irreducible brine saturation of 45%

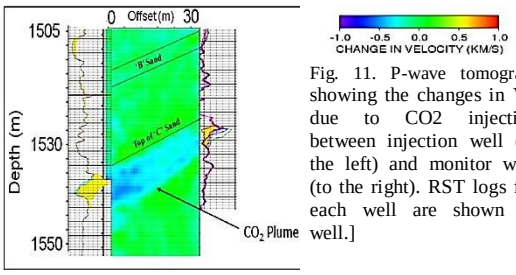

Fig. 11. P-wave tomogram showing the changes in Vp due to CO2 injection between injection well (to the left) and monitor well (to the right). RST logs for each well are shown as well.]

B.3.2 Sub-core scale heterogeneities and permeability anisotropy

Perrin and Benson [12] investigated in their study the effect of sub-core scale heterogeneities on CO2 distribution. It was found that sub-core scale heterogeneity has strong influence on the spatial distribution of CO2 and it may cause channeling through the porous medium. Fig. 12 demonstrates maps of CO2 saturation inside rock samples with different heterogeneity, both were heterogeneous but the second sample (sample B) has larger scale features (low permeability

and porosity bedding parallel to injection direction) [12]. For the first sample (A), high porosity layers correspond to high CO2 saturation and vice versa. On the other hand, for the second sample (B), some high porosity layers are isolated from the inlet face of the core by low porosity layers. The CO2 distribution in this case was largely affected by the orientation of the bedding in the rock (permeability anisotropy) where CO2 bypassed large portion of the core. In this case, the displacement efficiency was limited by such heterogeneities and the residual brine saturation stays higher that of the first sample [12]. Irreducible brine saturation in sample A was found to be 0.44 while it was 0.62 for sample B [12]. That is, larger heterogeneity and permeability anisotropy feature can result in higher irreducible brine saturation. As a result we may infer that sample B tends to have more patchy saturation pattern compared to sample A.

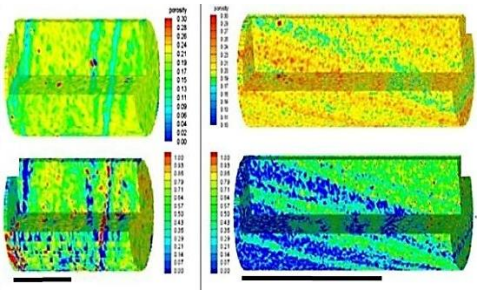

Fig 12. 3D maps produced using CT scan; A and B showing porosity map for two different samples while A' and B' show the CO2 saturation distribution at steady state of CO2 fractional flow of 1. Injection was carried out from the right side of the cores 12].

RESULTS

From all the analysis it can be stated that the consistent with the amount of irreducible brine saturation for both samples as mentioned earlier. That is, sample B has more irreducible water which suggests more patchy saturation pattern compared with sample A. Both samples however seem to exhibit patchy saturation pattern although at different extent. This can be again due to the presence of heterogeneity and low permeability (and porosity) zones with certain orientation where CO2 may not displace brine.

Table 1: summary of parameters and results used to obtain the critical diffusion length for both samples, viscosity was obtained from NIST webbook at the conditions specified below.

PARAMETER	SAMPLE (A)	SAMPLE (B)
Permeability	45md	430md
Experimental Conditions	T=63C P=12.4 MPa	T=50C P=12.4 MPa
CO2 viscosity	3.18E-5 Pa.s	4.4E-5 Pa.s
Bulk modulus of CO2	0.1 GPa	0.1 GPa
Calculated Critical diffusion length (Lc)	4 cm	9 cm

Uniform fluid saturation might be then expected to happen when the rock is homogeneous or when there is no permeability anisotropy. Examining the previous statement, Lc was calculated for a relatively homogeneous Berea rock and compared with the fluid saturation from the CT scan as demonstrated in Fig. 13. The rock properties and CT scan was obtained from Zuo et al. [13]. From Fig. 13, we can notice that the brine and CO2 saturation are present in a scale smaller than Lc which suggests a uniform saturation pattern for such a homogeneous sample.

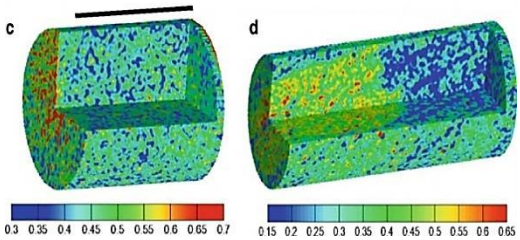

Fig. 13. CT scan of the CO2 saturation of a Berea sandstone sample [13]. The Lc of this rock is shown in a black bar. Note that the different saturation patches are distributed randomly within the rock (represented by different colors) where patches are smaller in size compared to Lc. This suggests a uniform saturation pattern. This sample will be referred to as sample C.

DISCUSSION

This paper represents the results for typical irreducible water saturation, fractional flow, sub-core scale heterogeneity analysis and permeability anisotropy suggest that the saturation style tend to be patchy in general in soil of Bangladesh. Rocks usually exhibit sub-core scale heterogeneity and permeability anisotropy which can limit the displacement efficiency and result in patchy saturation as CO2 occupies preferentially some large connected pores. The presence of large heterogeneities and permeability anisotropy features can increase the irreducible water saturation and cause channeling in the distribution of CO2. The comparison conducted between the critical diffusion length and CO2 saturation CT scans revealed that the saturation tends to be patchy.

CONCLUSION

This paper highlighted some aspects related to CO2 saturation estimation in carbon sequestration based on time-lapse seismic in the soil of Bangladesh. It discusses how engineering data and concept can provide useful information regarding some factors that affect the inversion from velocity changes to obtain CO2saturation in developing countries, like Bangladesh. The following point to be considered:

- Downhole pressure measurement or Buckly Leverett solution (if measurements are not available) can be used to obtain the pressure build up whose impact on velocity should be removed from the seismic 4D signature.
- Fluid sampling in the storage reservoir can give information about the changes in the fluids compositions and pH which can be used to infer geochemical changes in the rocks.
- Core-flood experimental studies can provide useful data average maximum and average expected CO2 saturation which can be used to constrain and validate the saturation estimate from seismic.

ACKNOWLEDGMENT

This study was prepared when author had been serving Stanford University as a graduate researcher under supervision of Dr. Lou Durlofsky and Dr. Adam Brandt. Special thanks to Dr. Sally Benson who patiently discussed all the queries over times. The study benefitted from contributions and cooperation of Stanford Center for Carbon Storage under the criteria of Geochemical Processes and Permanent Storage Research who reviewed this work and made suggestions for improvement and betterment.

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ID P1 **A3-11**

Cumulative Environmental Impact Assessment of Narail Sub-Project

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ABSTRACT

Cumulative environmental impacts are caused by the aggregate of past, present, and foreseeable future actions. Traditional environmental impact assessment (EIA) usually focuses on single-project development undertaken by single proponents in a narrowly defined physical area and defined time frame but cumulative impact assessment (CIA) means the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects and the effects of probable future projects. That is why cumulative impact assessments especially for water sector project are important and essential. This study has assessed cumulative impact for the compartment one of Southwest Area Integrated Water Resources Management Project (SWAIWRMP) implemented in Narail, Bangladesh. This study screened twelve environmental parameters which are of cumulative in nature. However, detail assessment was done for six parameters based on the importance and available information. The analysis shows the intensity of the impact i.e. additive or multiplicative as well as compares the effect with single project impact. The EIA carried out by SWAIWRMP eventually didn't address the cumulative environmental impact. Therefore attempt was taken in this study for investigating such impact and to suggest the mitigation measures to minimize the negative impact due to CI related to water resources.

INTRODUCTION

The Narail sub-project (SP) is located in Narail and Kalia Upazila of Narail district and Abhoynagar Upazila of Jessore district. The SP lies between latitude 23º15´ N and 22º55´N and longitude 89º24´E and 89º36´E and is bounded by the Chitra River to the east and Bhairab River and Afra Khal to the west. The study area is under Tularampur Union and denoted by Compartment one. Southwest Area Integrated Water Resources Planning and Management Project aims to rehabilitate and upgrade the existing flood control and drainage/irrigation (FCD/I) schemes in the southwest region of Bangladesh, so as to achieve their maximum development potentials in terms of agricultural and fishery production and incomes of beneficiaries in a sustainable manner. Study area of this research is 1804 ha and situated within Narail Sub-Project in compartment no one. Beside the Afra River six regulators exist in Tularampur union of compartment one. This study area is located in the upstream of the Afra River. There are a number of existing and proposed infrastructures in the Sub-Project area; which might have cumulative impact. Objectives of this study are; a) to identify important environmental parameters for SWAIWRMP, b) to screen parameters which may have cumulative impact, c) to assess cumulative impact of different parameters, and d) to suggest mitigation measures which will address cumulative environmental impacts

From the study, it has been seen that almost every parameters are cumulative in nature. Cumulative impacts are, in fact, the consequence of many interacting factors; both in the past and the present, and their combined effects are not always well understood according to Abraham (1998) [1]. The impact on capture fisheries is multiplicative in nature and it is negatively affected by the sub-project interventions. Regarding wetland, soil quality and flooding all are affected negatively by the sub-project intervention and the impact of these parameters on people's livelihood is quite tangible. However, irrigation facility and employment opportunity have positive impact on people's living. Crop production and employment opportunity of the study area had been increased significantly after completion of regulators. The environmental management plan had been given with potential measures with a view to mitigate the negative impacts. The study made few recommendations for wellbeing of the project stakeholders and future follow up study and research. At last it can be concluded that a project should be taken after conducting cumulative impact assessment rather than conducting traditional EIA considering impact of the single project

MATERIALS AND METHODS

Primary and secondary data were collected through focus group discussions (FGDs), key informant interview (KII) and individual interview was conducted as well as secondary literatures were reviewed to assess achievement of these objectives and also to assess the cumulative impacts. Besides some field assessment was done e.g. fish catch assessment. Several field visits were performed to get field data and to know the stakeholders perceptions, to observe the physical situation and to understand the project as well. The methodology for analysis of environmental impacts was developed following EIA Manual (FPCO, 1995) [2], Guidelines on environmental issues related to physical planning, Local Government Engineering Department (1994), and also through reviewing related literature.

Among parameters, CIA was analyzed for six parameters based on its importance to the people of the study area and for which data is available. Impacts by parameters which are cumulative in nature had been analyzed first by considering individual project. After that impacts by multiple projects were considered. Qualitative information, conceptual arguments was followed for CIA of those parameters. In summary, following steps had been followed for CIA: identification of problem with people participation and scoping. Selection of important environmental parameters and cross verified in study area. Parameters which are cumulative in nature were analyzed by network analysis as well as arguments were given. Based on people view and importance; parameters were selected for cumulative impact analysis (CIA). Cumulative impact was analyzed by using conceptual analysis and framework [5], hydrological analysis with both qualitative and quantitative information. Mitigation measures had been suggested based on the results of the study.

RESULTS AND DISCUSSION

At the beginning, important parameters were selected from secondary literatures and questionnaire survey [3]. By reviewing existing problems in the study area, following parameters given in Table 1 were selected and cross verified during the first field visit. After primary selection, field reconnaissance survey helped to find out the relationship/ importance of the parameters within the study area. For more verification, four FGDs had been conducted to check the accuracy of the selected parameters and to select new parameters, which study area people may consider important.

Second objective of the study is to screen parameters which are cumulative in nature. Network analysis and interaction diagram was done to understand the inter relationship among parameters. Network analysis also helped to realize the consequences of the project activities. Rationales [4] are provided below to describe how cumulative impacts are occurring in the study area and how these parameters are considered cumulative in nature.

Table 1. List of important parameters

Group	Name of the parameter
Aquatic Ecosystem	Capture fisheries Culture fisheries Aquatic habitats Water body or wetland area
Human interested related parameter	Irrigation facility Employment opportunity Navigation Landscape
Physico-chemical parameters	Soil quality Flooding Water logging GW table

A. Aggregate of Past, Present and Future Actions

Capture fisheries are decreasing day by day because no mitigation measures have been taken after negative impact on capture fisheries occurs due to a regulator. Again a new project was taken without taking any mitigation measures to revive this sector. Siapagla regulator was constructed in 1998. It affected capture fisheries both directly and indirectly. However, without taking mitigation measures another new gate namely Debipur was constructed in 1999. That is why in this area cumulative impact is occurring on capture fisheries in a sense that impact of Debipur regulator is now adding with the impact of Siapagla regulator. As a result, more wetlands are shrinking, fish habitat is decreasing. As farmers at present allow only limited water to enter into the project area that's why interconnection of wetlands during monsoon has been lost.

B. Cumulative Impact Doesn't Follow Political or Administrative Boundary

Cumulative impact mainly occurs according to basin wide boundary. That is why all wetland, irrigation, capture fisheries and aquatic habitat outside of project boundary are also affected because of project activities. Cultivable fields in Madhurgarea scheme area are washed away in monsoon season because of spilling of flood water caused by the impact of the adjacent project namely Boramara and Debipur regulator. It can be termed "flood risk transfer" by establishing regulator in the flood affected area namely Madhurgarea. Wetlands of this area are also decreasing because of regulators on both sides. For this reason a new regulator is constructed in Madhurgarea to avoid temporary flooding. Regulators don't allow water to enter into the project area which decreases salinity intrusion and benefitting crop production beyond the project area as well. That is why people outside the project area are also getting additional crops because of this project.

C. Effect of Different Activities on Single Component

Different activities such as using fertilizer and pesticides for cultivation, decrease of wetlands and water flow, disruption of tidal effect, increase of sediment trapping all together affect capture fisheries and aquatic habitats negatively. Moreover, reduction of salinity intrusion and better scope for water conservation help irrigation and culture fisheries. As a result employment opportunities are increasing day by day due to better crop production and culture fisheries. There is mostly fertile and high land in Chanduliar char area. However, soil fertility is decreasing due to use of excess chemical fertilizer. Moreover, farmers are cultivating lands constantly as land has become protected now from sudden flood. That is why impact on such parameters irrigation, culture fisheries, and employment opportunity are also cumulative in nature because different activities are affecting them at a time.

D. Agriculture and Fisheries Practice over the Year's Affects Environment

Traditionally farmers practice same cultivation techniques and use chemical fertilizers, pesticides, hybrid seeds to get more crops. Soil quality is constantly affected negatively because of following same practices which are not affirmative for environment and for not taking any measure to reduce negative impact. It is one of the causes of cumulative impact. As fisherman community are poor and not aware about environment that is why they always catch mother fish and don't consider the fish breeding period. All of those causes synchronize together and for this reason certain fish species are being lost forever. This is also one of the causes of cumulative impact in the study area.

E. Repeated Removal of Materials or Organisms Affects Certain Feature in Environment

Though some fish species are endangered species e.g. foli, royna, meni etc in our research area, fishermen continuously catches those fishes instead of conserving them. Crops are being cultivated round the year and soil does not get any rest. Repeated activities are affecting many environmental parameters especially soil fertility, capture fisheries and aquatic habitats.

F. Repeated Environmental Change is also one of the Causes of Cumulative Impact

In our study area, Farakka barrage disturbs water flow in Afra River which is one of the causes of rising bed in Afra River. That is why sudden flood occurs. Many species such as chital fish, hilsha fish are disappearing because it needs deep water to sustain. Livelihood of people (boatman, fisherman), and landscape are changing. GW table is lowering day by day as there is less water in the river basin. This scenario started after 1972 and same situation continues over the year. That is why impact on landscape, navigation, soil quality, GW table, flooding is considered cumulative in nature.

Table 2. Root causes of decreasing fish production.

Root causes	Responsible	% of impact
Decreases of wet land Canal bed rises, length and width decreases and it can't accumulate water as per requirement of capture fisheries	Due to project activity	50
Uses of excess chemical fertilizer and pesticides Catches of mother and egg carrying fish	Human activity	20
River doesn't have adequate water depth for certain fish species	Due to external project impact	10
Decreasing of wet land, rising of canal bed	Impact of adjacent project	20

Source: Feasibility report of Siapagla SP and Madhurgarea SP.

G. Cumulative Impact Assessment for Capture Fisheries

Fish enters into the beel area through canal in Chaitro-Boishakh and gate remains closed. In Kartik people get much fish because of dewatering from the canal. Sometimes local people don't catch fish for certain periods inside the canal. It helps to increase fish production. Capture fisheries mainly breed in wetlands, deep pockets etc. As wetland is decreasing so capture fisheries are also diminishing. They are related with each other. Production of capture fisheries are decreasing year by year as river does not have enough flow, regulator controls water, wetlands are used for irrigation, population is increasing, poverty is not decreasing rapidly, and consequently jobless poor people are catching mother fish and fingerlings. These factors all together are responsible for declining of capture fisheries.

H. Sample Calculation of Assessing Cumulative Impact

Given, Post project production of fisheries in Siapagla khal = 7.20 ton. Existing production of fisheries in Siapagla khal = 3 ton = (7.20-3)/7.20 *100% = 58%

Same procedure has been followed for the calculation of all parameters. After getting percentage value following scale is used to analyze cumulative impact on capture fisheries. Production of capture fisheries after project became less than half before pre project condition (projection on after project condition is also showing the same results). Moreover species are also decreasing due to several causes (Table 2). In this case multiple impacts on single component are seen. To analyze cumulative impact, impacts of other project/activity on respective project and existing field condition in 2008 were identified through FGDs in study area.

Table 3. Decreasing of fish production due to individual and cumulative impact (2008)

Name of the SP	Impact due to respective project	Impact of other projects/activity on respective project	CI
Sia pagla (1998)	-3	-1	-4
Madhurgarea (2008)	-3	-2	-5
Boramara (1995)	Data is not available		
Panu (2002)	-3	-1	-4

Source: FGD of this study

Formula: Total impact= sum of individual impact ± impact of other projects

Column 4 = Col 2 + Col 3

Scale used for assessing the cumulative impacts related to % value:

>0-20%	>20 -40%	>40-60%	>60-80%	>80-100%
1	2	3	4	5

Table 4. Summary of result showing CI of selected six parameters

Parameter	Before project	Projection of single EIA	Existing condition due to CI
Capture fisheries	Fish production from floodplain =86.65 ton; permanent water body= 18.66 ton	Floodplain= 7 ton Permanent water body = 7.53 ton	Floodplain= 2.80 ton Permanent water body = 3.15 ton
wetland	Floodplain area (F2+F3)=800 ha Permanent water body = 43 ha	Floodplain area (F2+F3)= 65 ha Permanent water body = 43 ha	Floodplain area (F2+F3)= 0 ha Permanent water body = 0 ha
Irrigation facility	10518.24 ton	15616.7 ton	18637.36 ton
Employment opportunity	People used to work only as wage labour during rice harvesting period	There are available temporary and new income opportunity will be generated e.g. rickshaw puller, SME entrepreneurship, culture fisheries etc	Based on field data it had been found that employment opportunity was increased more than projected.
Soil condition	Soil condition was good and it didn't require much fertilizer	It was not projected during EIA	Soil fertility was decreased and it requires more chemical fertilizer and pesticides
Flooding	Flood occurred every 2 and 3 years during monsoon	Structures will help to control flood	Flood risk transferred to the adjacent area

I. Justification of impacts of other projects on respective project

Qualitative information from FGD shows that production of capture fisheries decrease after implementation of individual project than earlier period available amount. Qualitative information converted to numerical value for analysis. Nature of impact on capture fisheries is multiplicative. If one breeding season of natural fish affects it decreases production multiplicatively. Adjacent project mainly affects main project area regarding capture fisheries by decreasing wet land area and disturbing fish breeding route.

CONCLUSION

In this study it has been found that availability of capture fisheries has become less than half of the pre project situation and some species have been lost due to cumulative impacts. CI is about 50% of total impact and multiplicative in nature. Decreasing trend of wetlands due to respective and other projects show negative impact on wetlands. After completion of all regulators wetlands will totally disappear in the SP area and CI is 60% of total impact and additive in nature. Impact on irrigation facility is positive. Crop production increases drastically after implementation of respective projects. Moreover other projects also facilitated to increase crop production directly and indirectly beyond project area. CI is 40% of total impact and additive in nature. Employment opportunity was generated during construction of regulator and also after completion of regulator. Impact on employment opportunity is positive in the SP area. It is additive in nature. Flooding is the fact of implementing project for which new projects are demanding in the study area. Scenario of flooding shows us that mitigation measures and CI should be analyzed properly before implementing new project. The consequences of flooding are multiplicative in nature.

ACKNOWLEDGEMENT

The paper was written based on the M.Sc thesis conducted under IWFM, BUET. Author would like to thank especially SaciWATERs for giving opportunity to hold a prestigious award SAWA Fellowship and for funding to complete research work successfully. In addition, LGED, IWFM and CEGIS helped to carry on the research work by providing data.

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ID 98 A3-12

Recognition of Climate Change Induced Migrants under Legal Framework: Looking for an Appropriate Way

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ABSTRACT

In the 21st century climate change is considered the prime factor behind present and mostly future migration. But unfortunately the impact of climate change on migration was not duly addressed in any legally binding international instruments. The paper focuses on the absence of globally binding legal protection for the climate migrants as well as for the adoption of such an instrument that will encompass unheeded issues of migration. The migrants induced by climate change needs a very special protection under an international legal instrument by which the developed countries will be under compulsion for providing them a special treatment distinct from ordinary migrants and the political refugees. Sometimes in many literatures the terminologies such as "environmental" or "ecological refugee", "climate refugee", "internally displaced persons", "migrant etc. overlap with each other and as a result, because of wrong application of terminology the migrants induced by climate change get deprived of the rights that they are supposed to be entitled.

INTRODUCTION

The intergovernmental panel on climate change (IPCC) estimated that by 2050, 150 million people around the globe could be displaced because of climate change factors. Professor Norman Myers of Oxford University argued that "when global warming takes hold there could be as many as 200 million people displaced by 2050 by the disruptions of monsoon systems and other rainfall regimes, by droughts of unprecedented severity and duration, and by the sea level rise and coastal flooding**.** Again, Stern review on the Economics of climate change in 2006 and a Christian Aid report in 2007 estimates displacement of respectively 200 million and 250 million people by climate change related reasons. The human rights of the climate induced migrants must be given a special sanction taking into the account of the distinctiveness of the climate migrants from the regular migrants.

IMPACT OF CLIMATE CHANGE IN MIGRATION: A CASE STUDY OF BANGLADESH

One of the most affected victims of climate change is Bangladesh. It is especially vulnerable because 30% of its land falls in the coastal belt where nearly 35 million people live in. Two thirds of the land of Bangladesh is less than 5 meters in height from sea level. Once the people living in the coastal belt are forced to move to the plain land due to climate change, how the country with a high density can accommodate such a large number of populations in this small land. The Global Climate Risk Index 2011 recognized Bangladesh as the country most vulnerable to extreme weather events and the one most affected in the period of 1990-2009. The IPCC estimates that climate change will contribute to 0.6 meter or more of global sea level rise by 2100. According to a World Bank report, Bangladesh will face 30 cm and 50 cm sea level rises in 2030 and 2050 respectively. Coastal inundation, sea water intrusion into fresh water resources and soil salinization are likely to compromise fresh water availability and adversely affect coastal agriculture. Since it is agriculture based country, the affect in agriculture directly injures livelihood of the people. The salt water intrusion from sea level rise in low lying agricultural plains could lead to 40% decrease in the food grain production. Then it becomes the question of existence and livelihood. A recent study has revealed that sea levels in the Bay of Bengal have risen much faster over the past few decades. As a result, low-lying and small islands are at great risk. Recent satellite images show that the New Moore Island or South Talpotti Island in the Bay of Bengal has disappeared due to sea level rise. If the recent trend of climate aggression does not change Bangladesh alone will outnumber the total number of the current refugees worldwide.

CLIMATE MIGRANTS: LOOKING FOR A LEGAL RECOGNITION

The tragedy for the climate victims who are forced to migrate is that they are called by different agencies by different terminology. The different terminologies used to address them are "ecological and environmental refugees", "climate refugees", "climate change migrants', "environmentally-induced forced migrants" etc. The use of the term "environmental refugees" or "climate change refugee" is not justified because the particular term "refugee" is commonly used and legally defined in the 1951 Refugee Convention. According to Article 1A(2) of the 1951 Convention and Protocol Relating to the Status of Refugees, the term refugee shall apply to any person who owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality. The basic requirement to fall under the definition of "refugee" there should be a well-founded fear of persecution and of course, persecution is something which is obviously political in nature. The basic distinction between a refugee and a migrant caused by climate change is that the latter does not move because of fear of persecution. Again to qualify as "refugee" as per the 1951 Convention, people must cross international border. But it is not the fact that climate victims leaving the place of their habitual residence are always moving beyond state boundary rather at first step, they move to the other places inside the country. On the other hand, by definition, the internally displaced persons (IDP) are they who flee natural and man-made disasters and remain in their country. But the climate driven migrants of small, low lying and island countries are mostly victim of disasters caused by developed, industrialized countries. Moreover they need to cross border unlike IDP. The attempt to put the "climate related forced displaced persons" into the category of "internally displaced persons" as well as to the "political refugee" will undermine the special protection required for these climate victims.

DO THE EXISTING INTERNATIONAL INSTRUMENTS ADDRESS THE CRISIS?

Still there is no room for the climate related forced migrants in the existing legal framework. The UN Refugee Convention does neither cover nor comply the core characteristics of the climate change induced migration crisis. Since the climate related induced migrants does not fall in the definition of refugee as well as IDP, UNHCR does not have mandate to address these unattended group. On the other hand, United Nations Framework Convention on Climate Change (UNFCC)

has not clearly said anything about migration issues either internal or cross border resulting from climate change. So it is crystal clear that existing international instruments do not rightly address the needs of climate victim from migration perspective.

CONCLUSION

Many people of the globe will be losing their place of birth, motherland, identity, nationhood, ethnicity, history, tradition, values and customs due to climate change. Migration resulting from climate change will be remaining no more a myth but reality soon. Now it is high time to adopt a sustainable approach by creating an international and regional legally binding framework so that the human rights such as right to life and livelihood which are very much inherent to a human being by virtue of being born as a human creature is guaranteed for that unfortunate group of climate induced forced migrants.

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