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Achieving Food Security for the Poorest Through the Use of Digital Video ICT

A K M Zakaria[1]

Abstract

A series of Women-to-Women digital videos that explain and demonstrate best practice for the production, selection and storage of rice seed have been shown to thousands of poor women in their own villages, with the help of local service providers with access to VCD operating equipment, such as shops, cable TV operators, NGOs, schools, tea-stalls and richer farmers. Women who have watched the videos twice or more have reported that as a result of implementing the suggested practices, they could save an average of 45% seed per acre and have increased their boro rice yields by an average of 52% and t-aman yields by an average of 75%. This provided an overall RSS increase of 147% per household and promoted them from food deficit to food surplus family, at no extra cost. Many of the women reported that they had gained respect from their husbands as a result of this increased productivity.

Introduction

More than 90% of rice farmers in Bangladesh rely on seed that they have saved from a previous crop. Much of this seed is contaminated with disease and weed seed and this is leading to declining yields. Furthermore, farmers discovered that they must dry *boro* rice varieties that are harvested at the end of the dry season during the succeeding rainy season. Drying seed during monsoon conditions presents a serious problem since rice seed / grain is normally dried by solar radiation on bare earth within village compounds or on open roads.

In early 2002, RDA initiated several participatory activities as part of the 'Seed Health Improvement' sub project (under the DFID-funded 'Poverty Elimination through Rice Research Assistance' Project). Field officers from the Rural Development Academy (RDA), in association with two local NGOs, travelled from village to village collecting local women's innovations concerning the processing of rice seed. Simple technologies such as the use of portable seed drying tables, picking out spotted/diseased seeds, using teeth to determine seed moisture and a candle to eliminate oxygen from storage pots were validated scientifically. Following skills training provided by UK-based Countrywise Communication and CABI Bioscience, field workers from RDA, produced four short, standalone training videos on seed spots and sorting, seed flatation, drying and storage technologies (Table 1).

[1]. *Joint Director, Rural Development Academy (RDA), Bogra*

Table 1: Post harvest interventions addressed in VCDs

	SEED SORTING	SEED FLOATATION	DRYING	STORAGE
Brief description of technology	Manually remove diseased seed	Add salt or urea to a bucket of water until an egg floats; drop rice seed into the water and remove any seed that floats to the surface	Make a bamboo table or bench for drying rice; it can be quickly moved in - doors in case of rain	Paint an earthen pot; fill it with rice seed, do not leave a dead air space; add *neem* or *bishkatali* leaves and seal the pot. Store the pot on raised platform
Origin of knowledge	Scientific principles; level of outside knowledge	Small modification of existing practice	First drying tables made through participatory technology development	Combined scientific and local knowledge and practice

(Source : Van Mele, and A.K.M. Zakaria, 2004).

Over the past two years, with the help of funding from the Swiss Agency for Development and Co-operation (SDC), the videos have been re-edited with additional footage and extracts have been made as video-clips for use in Bangladesh TV's popular farming programme, *Mati-O-Manush.*

Spreading the message

In order to reach many thousands of women with the information contained in the rice seed videos, RDA field workers identified several different 'service-providers' (organisations that have facilities for showing videos) in three districts. The service providers selected were village cable TV operators, local NGOs and schools. All were willing to show the videos free of charge. After a short awareness-raising training session the service-provider staffs were given copies of all four videos in a VCD format. Records were kept of the numbers of people who attended the shows. Between 2005 and 2007 the selected service-providers gave a total of 297 rice seed VCD shows which were attended by a total of 7130 women and 8000 men. RDA built on the success of this new approach to knowledge dissemination by distributing 232 more VCDs to groups of women who had come together in order to identify suitable venues for showing the VCD within their own communities and to 32 more service-providers in nine districts, mainly road-side tea stalls and also schools, grocery shops and local NGOs. This led to an additional 8600 more VCD shows, attended by a total of 157861viewers mainly women farmers.

Assessing the impact

In order to assess the impact of watching these VCDs on the amount of seed saved and any changes in rice yield, a total of 100 women from food insecure households were interviewed by RDA field staff in 10 villages and in four districts, during 2007. Seventy percent of the women

interviewed had watched the VCDs twice, while the rest 30% of them had watched the VCDs three or more times. The women said that they had watched the VCDs in houses of neighbouring affluent farmers who own VCD players and other similarly resourced local meeting places, such as primary schools, tea stalls, village markets and grocer's shops.

Livelihood systems of South Asian countries like Bangladesh are mostly rice based. Rice being central to the livelihoods of the rural households of these countries its production and availability can be considered as the indicator of household food sufficiency status (FAO, 2004). In order to assess the change of household food sufficiency status rice self- sufficiency index (RSSI) was calculated using the following formula (S. Page, 2006):

$$\text{RSSI (\%)} = \frac{\text{Potential paddy yield} \times \text{Land holding}}{\text{Annual paddy requirement}} \times 100$$

Annual paddy (unprocessed) requirement for each household was calculated considering the number of dependent adults, adolescents and children under 10 years and FAO's recommendation of energy intake (annual intake is @ 365 kg of unprocessed paddy rice for adult, 274 for adolescent child over 10 years and 183 kg for a child under 10 years). The women's own yield data in terms of kg of paddy/ha is used to calculate the RSSI (%) for each household.

Each female respondent was asked about the size of her family's landholding and that of any leased in land, the number and ages of her children as well as any differences in seed use and rice yield (transplant-aman and boro) before and after watching the VCDs.

Table 2. Comparative rice production level before and after watching VCDs

Factors	Before watching VCDs			After watching VCDs		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Seed Rate (kg/ha)	37.35	74.70	62.44	14.94	44.82	27.71
Aman Yield (kg/ha)	1951.67	4460.96	3184.00	2788.10	5576.21	3934.00
Boro Yield (kg/ha)	2788.10	6412.64	4592.00	3903.34	6970.26	5453.53

Data presented in table-2 indicate that farmers are using nearly half of the seed rate after watching videos. The average seed rate was significantly reduced from 62.44 kg/ha to 27.71 kg/ha. Minimum and maximum seed rate after video intervention were also found as almost half compared to those of before video intervention. It indicates that the farming families were able to

reduce rice seed rate per unit area by 45% after watching VCDs twice or more and learned how to clean, select and improve storage condition of their seeds.

There is a strong possibility that the cleaned seed produced higher yields during both the boro and t-aman season. Farmers got paddy yield from 1951.67 to 4460.96 kg/ha in aman season while it was 2788.10 kg/ha to 6412.64 kg/ha in boro season before the video intervention. After the video intervention the yield range (kg/ha) was found as 2788.10 to 5576.21 (kg/ha) during aman season and (kg/ha) 3903.34 to 6970.26 during boro season. On an average, the yield was increased about 750 kg/ha in aman season and 862 kg/ha in boro season after the video intervention. These differences are statistically significant. Therefore it can be inferred that video intervention had enormous impact on rice productivity by decreasing seed rate and increasing yield.

Table - 3. Rice Self – Sufficiency Index (RSSI)

RSSI before watching VCDs			RSSI after watching VCDs		
Minimum	Maximum	Mean	Minimum	Maximum	Mean
19.79	517.32	147.24	36.21	1076.67	294.54

Data presented in table-3 indicate a substantial increase of rice self – sufficiency among the respondents. RSSI ranged from 19.79 to 517.32 before video intervention and it was 36.21 to 1076.67 after video intervention. An increase of 147.30 in RSSI was observed after the video intervention. This difference is statistically significant. The minimum and maxim RSSI indicate that there is substantial variation among the rural households regarding level of rice self sufficiency. The mean household status was subsistence (RSSI value = 100-200) before watching the video and the video intervention could successfully promote it to food surplus (RSSI value = >200) family category.

Conclusion

The results suggest that the poorest and the most food deficit farming families can reduce their rice seed requirement and increase their food security at no extra cost, simply by adopting and implementing a series of improved practices concerning the selection and storage of rice seed that they have watched twice on a RDA developed VCD. Plans are being made to distribute these VCDs even more widely in Bangladesh and surrounding countries; and more follow-ups, over several seasons, focussing on the impacts of watching the VCDs on food insecure farming families are needed.

Women-to-Women videos offer a mechanism for the rapid dissemination of key extension messages amongst millions of poor farming families in remote rural areas. They also ensure that the original high quality training is maintained no matter how many times the session is repeated. The role of the group facilitator is to answer any question that may arise during the screening of the VCDs, through leading farmers' discussions and demonstrating any practises that require

clarification. However, this method of information transfer depends on the availability of hundreds of potential service-providers with access to reliable power supplies within the community for its success.

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Farmer's Knowledge on Rice Seed Management in Selected Areas of Bangladesh

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Abstract

Lack of healthy rice seed is considered as one of the most important constraints in rice production and productivity growth in Bangladesh. Healthy rice seed production and use are pre-requisites for accelerated agricultural growth and this can play a leading role in bringing rural prosperity and economic transformation. Therefore this study was carried out to generate information about knowledge on rice seed management. Data were collected from two different rice growing environments, namely Chuadanga and Gazipur. Primary data from 120 respondents of Boro and T. Aman seasons were used. Studies on farmer's seed management practices reveal that in most cases they do not purchase certified seeds. Most farmers grow their own seeds or exchange seeds of available varieties with other farmers. They usually select fields that appear to have healthy crops with no off types and relatively free of weeds, as source of seeds for the following season. If farmers' awareness on the importance of using clean and healthy seeds for growing is created/ increased, rice productivity could be significantly raised without much additional cost.

Introduction

Seed management is a knowledge-intensive technology with different components that many farmers may not be aware of where extension infrastructure is less developed. Improved seed management practices assume particular importance in situations where seeds used for plantings are mostly saved from the farmer's own harvests or exchanged with neighbors. The issue is of great importance for Bangladesh because of low education level of farmers and extensive use of farmer saved seeds (Hossain *et al.*, 2000).

Farmer-saved rice seeds are of low quality due to low purity, low germination rate and high moisture content. Using poor quality rice seeds for planting reduces germination, seedling and crop health, grain quality and yield. Extensive losses of rice grain yield and quality value occurs due to fungal diseases. There is lack of awareness among male and female farmers regarding the effect of poor quality rice seed and lack of knowledge of the impact of seed health and seed borne diseases and the possible ways in which these can be improved. In Bangladesh, 80% of the rice seeds planted are obtained from farmers' own harvest, 10% are exchanged or purchased from neighbors, and 10% are certified seeds supplied by government, or non-government organizations (NGOs), and private seed companies.

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Proper management of seeds is important for increasing the rice yield and could contribute to a substantial increase in household incomes. Studies of gender roles in rice farming suggest that poverty pushes female farmers of the households to take up very low productive and back breaking economic activities to supplement their meager household incomes. An increase in household incomes through improved seed management can also contribute to enhancement of women's welfare.

Seed processing (sorting, winnowing, floatation, blowing etc) helps in removing / reducing these seed conditions and contaminants leading to healthy crop, lowering pests and diseases and weed seed. As a result, the farmers will need less seed processing than before and eventually, farmers will obtain high quality seed.

Objectives of the Study

The main objectives of the study were as follows:

- To understand socio–economic characteristics of the rice growers.
- To find out the knowledge, attitudes, perceptions of rice growers and
- To know the seed management practices of the rice growers.

Methodology

Selection of area for analyzing the healthy seed technology

The study was conducted in Chuadanga and Gazipur districts. These two areas were selected purposively. Chuadanga district was selected as drought prone area and Gazipur was selected as favourable area.Chuadanga farmers used shallow tube well for irrigation in cultivating T.Aman rice, while farmers in Gazipur cultivated T.Aman rice in rainfed conditions. In the Boro season, however, farmers in both districts used shallow tube well for cultivating Boro rice and rice was intensively grown in those areas. Chuadanga farmers collecting rice seed from neighbouring country, BADC, farmers' exchange and the local market and most of the farmers of Gazipur farmers' main source of rice seed are BADC, local market, neighbouring farmers and collecting rice seeds from their own preserved. Four selected villages, namely Amirpur, Hatikata in Chuadanga, Maona and Khittapukurpar in Gazipur.

Socio-economic survey

Socio-economic and biophysical data were gathered using a structured questionnaire designed for this study, Information was generated from two villages in Chuadanga and Gazipur district through formal interview of 120 farmers. Provisions to capture other relevant information like farmers' perceptions, knowledge and attitude on healthy seed technology and practices on seed health management were also incorporated in the study.

Descriptive Statistics

Tabular method was used to classify the data by employing means ($\overline{X}$), percentages, ratios, χ^2 (Chi square) test were used for comparison of two means etc. To derive meaningful results, t –test for paired sample (the healthy seed plot and farmer seed plots) were used. In testing the hypothesis on the difference or equality significance was tested. For measures tabular form as well as other statistical program was used for analysis of the data.

Results and Discussion

Analysis of the duration of household head and spouse involvement in agriculture showed that in all sites, about 77 % of the male households were working full time (8.00 hrs / day) and 8 % working part time (6.00 hrs / day) in agriculture. On the other hand, about 50% of women were almost near to the male workers (7.00 hrs / day) in agriculture. Looking in gender involvement in Chuadanga and Gazipur, more men were working full-time. Analysis indicated that in Chuadanga and Gazipur, women had full-time involvement in agriculture. The findings suggested that in areas where men were heavily involved in agriculture, the women were also involved in almost with similar intensity (Table 1).

There are different factors affecting the duration of works (number of hours/day) during peak agricultural activities for male workers. Results from the multiple regression analyses indicated that the duration of works of male workers were affected by education of household, family size, number of male workers, non-farm occupation and modern variety acreage of the household at Chuadanga. On the other hand in Gazipur education of household head, family size and number of male worker significantly affected of working duration of the household head (Table 2).

In the Chuadanga site, the regression coefficient indicated that higher education of house hold head, number of male workers and non-farm occupation had a negative relationship with work by the household head. Similarly, larger family size and higher modern variety area indicated more work on their farm for the head of household.

The result implied that one unit increase of household head education, number of male workers and non farm occupation would significantly reduce the duration of working hours of household head by 0.152, 0.864 and 0.550 unit respectively. On the other hand, with one unit increase of family size and modern variety area the working hours of household head would be increased by 0.496 and 0.005 unit in Chuadanga site.

On the other hand, in Gazipur, the regression co-efficient showed that higher education of household head, and family size had a negative impact on working duration by the household head; it means family members of the household are not working in the field. Conversely, number of male worker had positive impact on work duration by the household head, perhaps because family members of the household had different working opportunity at the Gazipur site.

In Gazipur site, education and family members of household head was significant. It implies that one unit increase in education of household head and family size, the household head working hours would be decreased by 0.088 and 0.209 unit and one unit increase in number of male workers, working hour's duration of household head would be increased by 0.494 unit.

Farmers' sources of seed

Different sources of rice seed were found during the survey period. Sources were own stock, purchased from neighbors/friend, exchange with other farmers, government institute and neighboring countries (Table 3). In both districts about 85% and 87% of the sample farmers reported that they used rice seeds saved from their own harvests in the previous crop of Boro and T. Aman seasons, respectively. Another 6% reported that they purchased rice seeds from neighbors/friends during the Boro and T. Aman seasons. Seed saved from the harvest is the predominant source of rice seed in Bangladesh. Of the sample farmers, only 7% in the Boro and 4% in the T. Aman season reported that they obtained seeds from government institutions (BADC or research stations). In Chuadanga 2% of seeds were collected from Indian sources.

Reasons for using seeds from their own stock were that it is economical. Some Indian rice varieties are being cultivated by the farmers' in the Chuadanga border belt which were not available from government institutions. Farmers who had no stock of rice seed, they purchased seed from neighboring farmers or from government sources. A few farmers in Gazipur exchanged seeds with other farmers in the T. Aman season but none of them exchanged seeds in the Boro season (Table 3). In Chaudanga, none of the farmers exchanged rice seed with other farmers. Only a few farmers in Chuadanga and Gazipur purchased seeds from government institutes in both the seasons. None of the farmers in Gazipur purchased rice seeds from government institutions in the T. Aman season.

The nonparametric χ^2 results revealed that for both districts only government sources in T. Aman season were significant at 10% within the districts. Other sources were not significant.

Farmer's reasons for not changing rice seeds

In all the cases unavailability of good quality seed and unavailability of new rice variety seed were the main reasons for not changing the rice varieties, in both rice seasons. About 34% and 29% farmers replied that own seed quality was better than purchased seed in Boro and T. Aman seasons respectively (Table 4)

The $\chi 2$ results showed that new varieties seeds were not available and own seed was better than purchased seed was significant in the Boro and T. Aman seasons. Significant results were also found in the T. Aman season for seed price too high (Table 4). Other factors were not statistically significant.

Table 5 reveals the presence of different contaminants in seed stock for planting of rice seeds. Weed seeds and other plant parts were found 80% and 93% in samples respectively in Chuadanga. On the other hand, in Gazipur district discolored seed was found 90% during storage, broken and deformed seeds were found 77%.

The χ^2 results showed that between the two districts was significant at 1% level for presence of storage insects, other plant parts and broken and deformed seed during planting. Weed seed, soil particle and discolored rice seed were not significant (Table 5). It was assumed that farmers do not have awareness about the presence of contaminants in rice seed. But the results showed that in some cases farmers had awareness regarding contaminants in rice seed.

Table 6 revealed the farmers evaluation of rice seeds which they obtained from government sources. Table indicated that the seeds from government sources were of better quality in both the districts. Seventy-eight percent of farmers in both districts who obtained seeds from government sources reported that they were of better quality. Twenty seven percent farmers replied in Gazipur, that the seeds which they obtained from government organization were same as there own seeds compared to Chuadanga district. A negligible number of farmers in both districts replied that the seed was worse than their own seed.

Causes of strength (seedling vigor) of rice seedlings

Table 7 shows the causes of seedling vigor (strength of rice seedlings). In all the cases about 100 % farmers gave opinion that good land preparation was one of the important cause of strength of rice seedling, 93 % and 73 % farmers believed that good quality seeds and sufficient water were good for seedling vigor in Chuadanga and Gazipur, respectively.

The χ^2 results showed significant impact for sufficient fertilizer, use of insecticide, good quality seeds and sufficient water at 5% level in all the cases. Proper harvesting, threshing and drying were found significant at 1% level. Results showed that in all cases the proper storage system was not statistically significant.

Method of seed threshing

There are two methods for seed threshing was found in the study areas. Table 8 showed that about 53 % farmers of Chuadanga and 100% farmers of Gazipur threshed their seeds by manual operation; the other alternative method found in Chuadanga was paddle thresher.

Seed storing method

Different storing containers were used in Chuadanga and Gazipur for storing rice seeds. Among them were gunny bag, bamboo dole, drum, tin, and earthen pots were used in both districts. Polyethylene was used only in Chuadanga district. The most popular seed storing containers found in Chuadanga were drum (40%), tin (23%) and earthen pot (17%). On the other hand, at Gazipur it was gunny bag (37%), bamboo dole (13%) and earthen pot (50%). The most popular storage material used in Chuadanga and Gazipur was drum and earthen pot respectively (Table 8).

The significance results were statistically tested by χ^2. It indicated that difference in threshing method between districts was found significant at 1% level. On the other hand all storing material containers were significant at 1% and 5% level except polyethylene material (Table 8).

Farmer's knowledge about bad rice seeds

The study revealed that the insect, diseases, weeds, rice mixtures and improper storage management were more or less equally responsible for bad rice seeds for planting. Regarding transplantation, 97% of Chuadanga farmers felt that rice mixture was bad for rice seeds compared to insect, diseases and weeds, but 100% Gazipur farmers replied that seed born diseases was the main reason for bad rice seeds compared to insect, rice mixture and weeds.

In all the cases 98% farmers expressed the opinion that rice seed mixture was bad for seeds and 55% farmers also reported that seed mixture was worst for rice seeds. This might be happened because farmers could use insecticide and pesticide to control insect and diseases in rice field and they can remove seed born diseases from seeds by chemical treatment (Table 9). Gazipur farmers also mentioned other traits. About 13 % farmers faced soil particle and 3% farmers faced deformed seed for bad rice seeds. Very few farmers (3%) reported that unfilled grain was bad for rice seed but it was not worst for planting for both the districts (Table 9).

Effect of pests on rice seeds

Among rice diseases and insects *Bipolaris Oryzae* (Brown spot), *Sarocladium oryzae* (Sheath rot), *Pyricularia grisea* (Rice blast), *Rhizoctonia solani* (Sheath blight), *Rice Tungro virus* (Tungro) and Steam borer, Rice hispa and Rice bug insect are important for rice crop and seed.

Table 10 showed that 97 % farmers of both districts faced brown spot disease in their rice seeds. The reasons may be drought and light soil. In Chuadanga, sheath blight disease was found to be 97 %. The reason was that the farmers used Sharna (India) variety in Chuadanga, which was very susceptible to the disease. On the other hand, farmers of Gazipur did not cultivate Sharna variety and have not faced this disease. But 73 % Gazipur farmers reported their crops were affected by sheath rot disease and 100 % farmers affected by rice bug insect, which was very minor at Chuadanga.

In all the cases farmers of both the district reported their rice crop was affected by brown spot (97 %), stem borer (53 %) and by rice bug (52 %). The χ^2 results showed in all cases sheath rot, stem borer, sheath blight and rice bug were significant at 1% level and brown spot, tungro and rice hispa were not significant in both the districts.

Farmer's perceptions of controlling pests and weeds

Farmers of both districts took necessary measures to control pests and weeds. All had done manual weeding to control weeds from rice plots. To control insect and diseases 67% and 50% farmers in Chuadanga and Gazipur, respectively, applied pesticides in their crops. Forty percent farmers in Gazipur controlled by water management, none of the farmers of Chuadanga had done water management and used herbicides. By integrated pest management method 23 % farmers in Chuadanga and 7% farmers in Gazipur controlled insect and pest (Table 11).

Farmer's perceptions of problems in rice farming

The study covers farmers from diverse agro-ecological zones. Farmers in the study areas faced problems in rice farming. Problems reported by respondents are shown in table 12. From the farmer's opinions, problems were divided in two parts: i) Socio-economic and ii) Technical. The socio-economic problems were reported as relatively less important than that of the technical problems. The major socio-economic problems were reported as "lack of irrigation facilities (42%) and "low price of rice" (42%). High cost of fertilizer (17 %), lack of capital (15%) was mentioned as problems by a minority of farmers. In all lack of quality seeds were mentioned as a problem for only 15% of the farmers.

A considerable geographical variation was noted in the responses on socio-economic problems. The low price of rice was reported by the farmers of Gazipur. It was mentioned as a problem by a minority of farmers (13 %) in Chuadanga. Lack of capital was reported by 27% of farmers in Gazipur but by less than 5% by the farmers in Chuadanga. Insects, weeds and diseases were reported to be the most important biotic stress faced by farmers in both Chuadanga and Gazipur. More farmers in Chuadanga reported problems with diseases (33 %) and more farmers in Gazipur (100%) reported problems with insects. With regard to abiotic stress, farmers in Chuadanga reported drought as most important, while in Gazipur farmers reported lodging as important (Table 12).

The χ^2 results showed socio-economic problems like low price of rice, high cost of fertilizer and lack of irrigation facilities to be significant at 1% level and lack of capital to be significant at 5% level. Insects, disease and weeds were significant at 1% level (Table 12).

Conclusion

This study opted for descriptive and econometric tools to analyze the collected data. The socioeconomic characteristics of healthy rice seed users and non healthy seed users were described using descriptive statistics.

The male farmers spent their time in agriculture while in Chuadanga the female workers were higher (8 hrs per day). The regression co-efficient indicated that higher education, higher number of male workers and non farm occupation is significant and showed a tendency for the household head doing less work in agriculture in Chuadanga and Gazipur district.

Majority farmers of the study area used their saved seed, which they had preserved from their harvested paddy during the seasons. Other different sources of rice seeds identified in the study area included purchase from neighbors, exchange with other farmers, and government institutions. Farmers are not changing rice seed because of un-availability of good quality seed and new varieties.

Different seed contaminants damage and prohibit germination. Farmers feel that the seeds from government sources were better. More than 50% farmers collected seed from government

institutions. The main causes of the seedling vigor identified in the reported area are good land preparation and good quality seeds.

Chuadanga and Gazipur farmers threshed their seeds manually because this method helped them to collect good quality seeds. They stored rice seed in the earthen pot, gunny bag and metallic drum in the study area. These methods of storing help farmers keep their seed for a long duration and they can use the seeds in the following season.

Farmers' perceive that a little portion of yield reduction was caused by discoloration and smutted seeds. Seeds mixed with off types, deformed seeds, insect damage also reduced yield. Insects, diseases, weeds, rice mixtures and improper storage management are equally responsible for making bad seeds for planting. Chuadanga farmers' felt that rice seed mixture were responsible for making bad seed and Gazipur farmers' felts that diseases were the main reason for bad rice seeds. Brown spot and sheath blight were main diseases and rice bug was very minor in Chuadanga. Sheath rot disease was the main disease for Gazipur.

Majority farmers applied insecticide and pesticide to their crops. Farmers of the both districts used pesticides and controlled weeds manually. Major socio-economic problems were reported to be relatively less important than technical problems. The major socio-economic problems were lack of irrigation facilities, low price of rice, high cost of fertilizer and lack of capital. Insects, weeds and diseases were most important biotic stress faced by the farmers of the study areas. Insect and diseases were mentioned as major problem in both the sites. Other than the biotic stress farmers of Chuadanga reported drought as most important and lodging problem in Gazipur.

Table 1. Time spent by Chuadanga and Gazipur farmers and their spouse for farm works in the peak season.

Time spent (hours/day)	Values in percent					
	Chuadanga		Gazipur		All districts	
	House hold head	Spouse	House hold head	Spouse	House hold head	Spouse
Less than 6 hours	11	20	5	30	8	25
6 hours – 8 hours	71	33	83	67	77	50
Above 8 hours	18	47	12	3	15	25
Total	100	100	100	100	100	100

Table 2. Factors affecting the working duration during peak agricultural activities for male workers by districts.

Factors	Chuadanga		Gazipur	
	Regression co-efficient	Level of significance	Regression co-efficient	Level of significance
Farm size	-.006 ns	.091	.002 ns	.490
House hold education	-.152 *	.014	-.088 *	.036
Family size	.496 **	.007	-.209 *	.050
No. of male worker	-.864 **	.009	.494 *	.017
Non farm occupation	-.550 **	.002	.048 ns	.854
Modern variety area	.005 *	.034	.003 ns	.627
Irrigation area	.004ns	.186	-.005 ns	.415

R^2=.263
F = 3.663 **

R^2=.147
F= 1.775 **

**= Significant at 1% level * = Significant at 5% level ns = Not significant

Table 3. Sources of seeds of major rice varieties in two rice seasons by districts.

Sources of seeds	Percent of farmers sources of seed					
	Chuadanga		Gazipur		All districts	
	Boro	T. Aman	Boro	T. Aman	Boro	T. Aman
Own stock	77**(10.3)	85**(17.86)	94**(24.5)	88**(19.8)	85 ns(3.83)	87 ns(4.99)
Purchased from neighbors / friend	9**(24.03)	7**(27.46)	3**(28.12)	6*(26.47)	6 ns(.88)	6 ns(.001)
Exchange with other farmers	-	-	-	6*(26.47)	-	3 ns (2.12)
Govt. Institute	11**(20.8)	8**(24.03)	3*(28.12)	-	7 ns(1.67)	4 + (3.04)
Indian seed	3**(31.11)	-	-	-	2 ns (.93)	-
Total	100	100	100	100	100	100

Figures in the parentheses indicate the χ^2 results
** = Significant at 1% level, * = Significant at 5% level, + = Significant at 10%
ns = Not significant

Table 4. Reasons for not changing rice seed in Boro and T. Aman seasons by districts.

Reasons for not changing	Percent farmers					
	Chuadanga		Gazipur		All districts	
	Boro	T. Aman	Boro	T. Aman	Boro	T. Aman
Unavailability of good quality seed	33* (5.3)	26** (13.2)	44 ns (1.0)	36* (5.8)	39 ns (1.2)	32 ns (1.6)
New varieties not available	79** (16.3)	87** (30.5)	9** (42.25)	20** (27.0)	39** (56.0)	49** (57.4)
Price is too high	2** (44.0)	-	11** (39.0)	20** (27.0)	7ns (3.2)	12** (12.4)
Own seed is better than purchased one	8** (33.3)	4** (47.2)	53ns (.25)	47 ns (.64)	34** (24.5)	29** (29.4)
Yield is better	4** (40.3)	9** (36.8)	6** (49.0)	4** (63.4)	5 ns (.255)	6 ns (1.4)
Grown only in low land	-	2** (51.0)	-	-	-	0.8 ns (1.3)

Figures in the parentheses indicate the χ^2 results
** Significant at 1% level, * Significant at 5% level, ns = Not significant

Table 5. Farmers' awareness about presence of different contaminants in rice seed stock for planting by districts.

Contaminants	Percent farmers' had awareness on seed contaminants		
	Chuadanga	Gazipur	All districts
Weed seed	80** (10.8)	77** (8.53)	78 ns (.098)
Storage insects	7** (22.5)	97** (26.1)	52** (48.6)
Soil particles	17** (13.3)	37 ns (2.1)	27 ns (3.068)
Other plant parts	93** (22.5)	13** (16.1)	53** (38.5)
Discolored rice seed	70* (4.8)	90** (19.2)	80 ns (3.7)
Broken or deformed seeds	37 ns (2.133)	77** (8.5)	57** (9.7)

Figures in the parentheses indicate the χ^2 results
** Significant at 1 % level * Significant at 5 % level ns = Not significant

Table 6. Farmers' perception about quality of the seeds received from government sources by districts

Seed quality	Percent of farmers evaluation of government sources seeds		
	Chuadanga	Gazipur	All districts
Better quality	87	70	78
Same as own seed	3	27	15
Worse than own seed	-	3	2
No opinion	10	-	5
Total	100	100	100

Table 7. Farmers' perceptions about factors affecting seedling vigor (strength of rice seedlings) by districts.

Factors affecting seedling vigor	Percent of farmers perceptions about seedling vigor		
	Chuadanga	Gazipur	All districts
Good land preparation	100 (-)	100 (-)	100 (-)
Sufficient fertilizer	50 ns (.00)	20** (10.8)	35* (5.9)
Use of insecticide	13** (16.1)	-	7 * (4.2)
Good quality of seeds	87** (16.1)	100 (-)	93* (4.2)
Sufficient water	87** (16.1)	60 ns (1.2)	73* (5.4)
Proper harvesting, Threshing and Drying	10.0** (19.2)	77** (8.5)	43** (27.1)
Proper storage	-	3** (26.1)	2 ns (1.0)

Figures in the parentheses indicate the χ^2 results
** Significant at 1% level * Significant at 5% level ns = Not significant

Table 8. Different threshing and storing methods used for rice seed by districts.

Different method	Percent of different operation of rice		
	Chuadanga	Gazipur	All Districts
Threshing			
Manually(Hand beating)	53 ns (.13)	100 (-)	77** (18.2)
Paddle thresher	46.7 ns (.13)	-	23** (18.2)
Total	**100**	**100**	**100**
Storing			
Jute gunny bag	10 ** (19.20)	37 ns (2.1)	23* (5.9)
Bamboo doll	-	13** (16.1)	6.7* (4.2)
Drum	40 ns (1.20)	-	20** (15.0)
Tin	23** (8.5)	-	12** (7.9)
Earthen pot	16** (13.3)	50 ns (.00)	33** (7.50)
Polyethylene	10** (19.2)	-	5 ns (3.1)
Total	**100**	**100**	**100**

Figures in the parentheses indicate the χ^2 results
** Significant at 1% level * Significant at 5% level ns = Not significant

Table 9. Farmers' opinion about bad rice seeds and the worst for planting in Chuadanga and Gazipur districts.

Traits	Percent of farmers					
	Chuadanga		Gazipur		All Districts	
	Bad for rice seed	Worst of rice seed	Bad for rice seed	Worst of rice seed	Bad for rice seed	Worst of rice seed
Insects	17	3	93	60	55	32
Diseases	83	-	100	7	92	3
Rice mixture	97	90	-	20	98	55
Weeds	93	7	87	7	90	7
Soil particle and deformed seed	-	-	13	-	7	-
Soil particle and mouldy seed	-	-	3	-	2	-
Unfilled grain	3	-	3	-	3	-
Insect & diseases	-	-	-	7	-	3

Table 10. Farmer's opinion about affect of pests of rice seeds in Chuadanga and Gazipur districts.

Different rice pests	Percent of farmers opinion of pests in rice seeds		
	Chuadanga	Gazipur	All Districts
Brown spot	97** (26.1)	97** (26.1)	97 ns (.00)
Sheath rot	3** (26.1)	73* (6.5)	38** (31.0)
Sheath blight	97** (26.1)	-	48** (56.1)
Tungro virus	3** (26.1)	-	2 ns (1.0)
Rice hispa	13** (16.1)	3** (26.1)	8 ns (1.964)
Stem borer	87** (16.1)	20** (10.8)	53** (26.7)
Rice bug	3** (26.1)	100 (-)	52 ** (56.1)

Figures in the parentheses indicate the χ^2 results
** Significant at 1 % and * Significant at 5 % level, ns = Not significant

Table 11. Farmers perceptions for controlling of pests and weeds in different method at Chuadanga and Gazipur districts.

Operations/ Methods	Percent of farmers'		
	Chuadanga	Gazipur	All Districts
Applied pesticides	67 ns (3.3)	50 ns (.00)	58 ns (1.7)
Hand weeding	100	100	100
Water management	-	40 ns (1.2)	20** (15.0)
Consult with others	3** (26.1)	-	2 ns (1.0)
IPM methods	23** (8.53)	7** (22.5)	15 ns (3.2)

Figures in the parentheses indicate the χ^2 results
** Significant at 1% level * Significant at 5% level ns = Not significant

Table 12. Farmers opinion on problems encountered in rice farming by districts.

Problems	Percent of farmers problems in farming		
	Chuadanga	Gazipur	All Districts
Socio-economics			
Low price of rice	13 ** (16.1)	70 * (4.8)	42** (19.8)
High cost of fertilizer	3 **(26.1)	30 *(4.8)	17** (7.7)
Lack of irrigation facilities	83 **(13.1)	-	42** (42.9)
Lack of capital	3 **(26.1)	27 *(6.5)	15* (6.4)
Lack of good quality seeds	13 **(26.1)	17 **(3.3)	15 ns (0.1)
Labour wage high	7 **(22.5)	-	3 ns (2.1)
Machinery trouble	3 *(26.1)	-	2 ns (1.0)
Technical			
Insects	23 ** (8.5)	100 (-)	62** (37.3)
Diseases	33 ns(3.3)	97 **(26.1)	65** (36.4)
Weeds	3 **(26.1)	100 (-)	52** (56.1)
Lodging	7 **(22.5)	20 **(10.8)	13 ns (2.3)
Drought	70 *(4.8)	90 ** (19.2)	80 ns (3.7)
Rat	3 *(26.1)	-	2 ns (1.0)

Figures in the parentheses indicate the χ^2 results
** Significant at 1% level * Significant at 5% level ns = Not significant

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Below the Poverty Line: Limp Life of *Char*-dwellers

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Abstract

Most of the char-dwellers *live below all sorts of poverty lines drawn by different organizations. To measure poverty, so many definitions and poverty lines drawn by different angles and approaches with their own advantages and limitations offer us platforms to fight against poverty rather than confusions and problems. In defining the poverty and identifying the poor, an important aspect is that there should be a focus on the perceptions of poverty from both the poor and the professionals. Poverty can not be defined in the true sense unless we consider how the people of a particular society at a particular point in time perceive them as poor. In this paper, considering the perceptions of the poor and the professionals, an attempt has been made to focus on poverty and various socio-economic, psychological and environmental forces influencing the poor and categorization of the moderate and extreme poor has been done in terms of poverty line.*

Introduction

Poverty, perhaps, is the most connotative word and the number one killer in this world. "What poverty is taken to mean depends on who asks the question, how it is understood and who responds. Whose reality counts? Ours? Or theirs? Or more precisely: Ours, as we construct it with our mindsets and for our purposes? Or theirs as we enable them to analyze and express it" (Chambers, 2006). In case of helping the poor to uplift their socio-economic condition, a requirement of better explanation or analysis and measurement of poverty precedes any action to be taken. We need a crystal clear explanation about whom we define as poor, under what condition they are and the condition where we help them reach. Poverty is a multi-dimensional and relative concept. Robert Chambers has illustrated twelve interrelated dimensions and the interdependence of the dimensions of poverty. They are: material poverties, insecurities, physical ill-being, access to institutions, lack of information, lack of political clout, lack of education/capabilities, social relations, poverty of time, place of the poor and seasonal dimensions. On the other hand, there are a number of poverty lines or threshold such as $ 1 a day statistics, direct calorie intake (DCI), food energy intake (FEI) etc. The above mentioned dimensions or deprivations and poverty lines which we use to explain the poor and categorize them are the perceptions of the professionals. There is still room for new views or explanation from new angles. Therefore, the effort to analyze poverty from a quite different angle is reasonable as shapes and dynamics of poverty vary depending on its surroundings. In this paper, an attempt has been made to explain the poverty of *char*-dwellers and categorize them with the help of a blend of

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views of the poor themselves and the pro-poor professionals. In this process, firstly, the poor have been asked to categorize villagers into different wealth groups based on certain characteristics. Secondly, they have been allowed to explain the degree of poverty they felt throughout the year and then what factors were responsible for worsening or improving their economic condition. Finally, having analyzed their views and perceptions, an attempt was made to categorize them and factors have been identified which were responsible for their being involved in a particular category.

This study was conducted in *char Sthalnouhata* of Chouhali Upazila under Sirajgonj district in 2006. It is an Island *char*. This *char* is poorly connected to the mainland and is prone to acute erosion and flooding which make the inhabitants vulnerable. From the well-being analysis, we have got four categories of people living in this *char*. They are: Well off, middle, moderate poor and extreme poor. This study only dealt with the moderate and extreme poor.

Objectives

The board objective of the study was to explain the poverty of char dwellers from a blend of views of the poor themselves and the pro-poor professionals. The specific objectives were to know the poverty as perceived by the poor themselves, to identify social, economic, mental and environmental forces and their effects on the poor and to categorize the poor in terms of poverty line criteria.

Methodology

Data used in this article were collected from the study area using Participatory Rural Appraisal (PRA) Method. The study area *char* Sthalnouhata is naturally divided into two parts: southern and northern. In both parts of the *char*, some PRA tools were used to collect data. Interviews and four group discussions--two for the moderate poor and two for the extreme poor- -in each part of the *char* Sthalnouhata were conducted in order to cross-check the collected data. The philosophy, methods and analytical tools of the pro-poor professionals in the literature of poverty were used in analyzing the poverty data collected from the char- dwellers. Wellbeing analysis, seasonality analysis, histogram and pie chart were used as analytical tools to interpret the collected data.

Results and Discussion

The socio-economic characteristics permitting to categorize the char-dwellers as moderate poor and extreme poor are presented in the table below.

Table- 1: Characteristics of wealth groups as defined by the *char* communities

Criteria	Well off	Middle income	Moderate poor	Extreme poor
Land ownership (in decimals)	200-650	75-220	14-70	0-20
Annual Income	65000-100000	35000-60000	20000-30000	10000-15000
Food deficit month	0.3 month	2- 3 months	6-7 months	8-9 months
Taking meals two times a day	Take meals 3 times round the year	25-50 days per year	120-150 days per year	150-240 days per year
Occupation	Service, Agriculture, Business, Share cropping	Service, Agriculture, Business, Agricultural labour, Day labour, Share cropping	Agricultural labour, Day labour, small-business, Share cropping	Agricultural labour, Day labour, Beggar
Education	Class 1 to xii	Class 1 to xii	Illiterate to class viii	Illiterate to class v
Housing condition (based on roof, wall, concrete pillar, fence, bamboo, straw and furniture)	Very Good	Good	Poor	Very poor
Livestock	2 to 4 buffalos, 2 to 6 cows, 2 to 4 goats	1 to 4 cows, 2 to 4 goats	1 to 3 cows, poultry birds	Most of them have no assets, 1 to 5 poultry birds, goat
Tube well (in house)	All have 1 tube well	Most of them have tube well	Most of them have no tube well	No tube well
Latrine	All have Latrine	Most of them have latrine	Most of them have no latrine	No latrine
Savings per year	Good amount of money (10% of annual income)	Less amount of money (2-3% of annual income)	No savings	No savings

Source: Well being analysis, Facilitated by: Shafique and Saeem, Place: South Sthalnouhata, Upazila: Chouhali, Date: 23/02/2006, Participants: Rahim mollah, Saber Ali, Akkas, Kanu Miagh, Munna and other 7 persons.

It was found that there were clear distinctions between the moderate poor and the extreme poor in terms of six characteristics: land ownership, annual income, food deficit months, number of meals per day, housing condition and number of livestock per household. On the other hand, no significant difference was found between them in terms of the other five characteristics: education, occupation, tube well, latrine and saving.

These characteristics give us a picture of their standards of living. But these are not enough to describe them so clearly and accurately as we have seen them in reality. To our views, these can not be the only indicators to make a full judgment about their status. For example, a big family

with more than one earner may be rich while the family of similar members with one earner may be poor. Again, a moderate poor may have one or two characteristics of the extreme poor and vice versa. We, therefore, still need to explain their circumstances in some other ways--- the ways by which we can focus on the factors which influence their socio-economic life.

After the well-being analysis, *char*-dwellers were asked to explain the month-wise degree of poverty felt by them throughout the year.

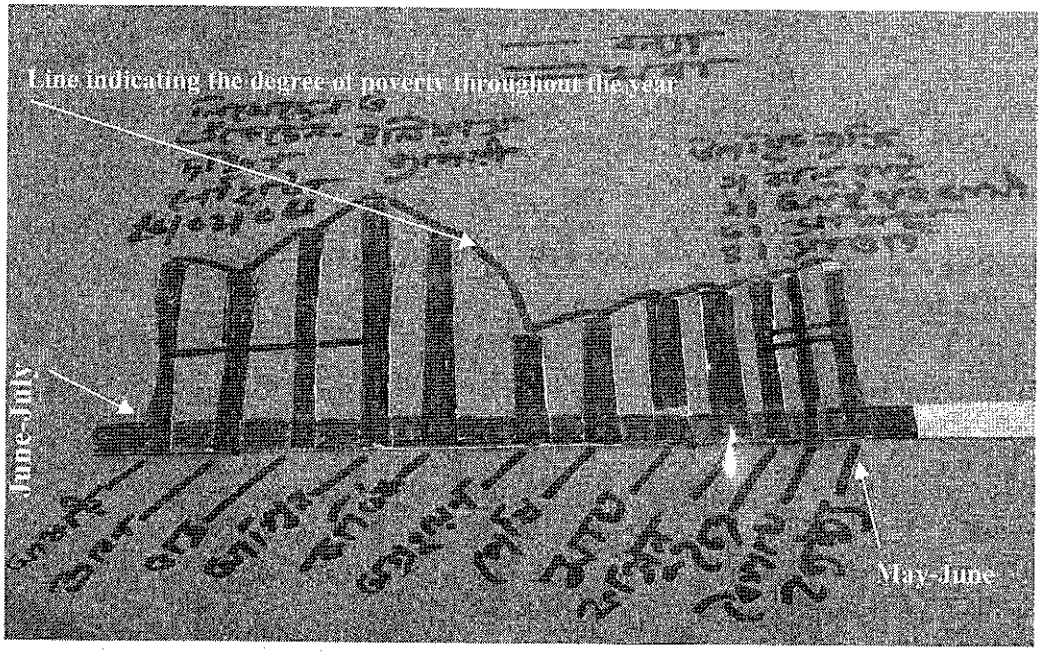

Fig-1: Degree of poverty throughout the year

Source: Seasonality Analysis, Facilitated by: Mizan, Drawn by: Ellias Bapari, Date: 26/02/2006, Village: Sthalnouhata, Upazila: Chouhali, Participants: Kalu Vai, Ayub Ali, Samad, Sattar and nine other villagers.

The histogram above reveals the fact that the year long poverty is their constant companion. They have shown June-July (Asar) as the first month and May-June (Joystho) as the last month of the year. Poverty is felt by them most severely in September-October (Aushin) and to a lower degree than the earlier month in October-November (Kartik). Poverty reduces considerably in November-December (Agrohayon) and prevails in the lowest degree than any other month of the year in that period. However, after this month, it is again on the rise. Poverty felt by them in the last three months is more severe than the preceding three months.

Having concentrated on the fact of the fluctuation of their degree of poverty they were asked to further mention the factors responsible for worsening or improving their socio-economic condition.

Table-2: Results of Cause and Effect Analysis

Social, Environmental and Economic Forces	Positive Effect	Negative Effect(s)
Flood	Makes soil fertile	Making land sandy, disease, loss of assets, scarcity of work, slow down of business activities, creating adverse condition for human and cattle
River erosion		Damage of land and house
Emerging char lands	Improves economic condition	
Fog		Damage of crops, making problems in loom work
Hailstorm		Damage of crops,
Attack of rat		Damage of crops
Storm		Damage of crops, trees and house
Borrowing money		failure in payment causes selling asset to pay back
Death of main wage earner		Reduces income, Declines living standard
Land and cow sharing/leasing	Improves socio-economic condition	
Increase earning member	Improves socio-economic condition	
Being widow		Declines living standard
Having a good harvest	Makes money	
Separation of income earner son		Reduces income, Declines living standard
Migration	Makes Money	Makes compelled to sell assets and/or borrowing , Declines living standard
Divorce		Increases in expenditure in the family of bridegroom's father/other
Disease		Illness, additional expenditure for treatment , remains unemployed until recovery
Dowry		Sale of assets and/or borrowing to bear expenses
Giving birth to baby		Increase in expenditure, reduces savings, Sale of assets and/or borrowing to bear expenses

Source: Seasonality analysis, Facilitated by: Porag and Mehedee, Place: North Sthalnouhata, Upazila: Chouhali, Date: 22/02/2006, Participants: Kalu Miagh, Haru, Nazrul, Kamal , Alam, Fakir Mollah and other13 villagers.

In the cause-effect analysis, it was found that there were 19 social, psychological, environmental and economic forces which affect their lots positively or negatively. Out of them, seven are natural and twelve are socio-economic forces. *Char*-dwellers are severely affected by natural calamities. Flood and river erosion are extremely harmful to the *char*-dwellers as has been mentioned by the participant villagers.

Analysis of Poverty from the Standpoints of Both Sides: Professionals and the Poor

Finally, an effort was made to categorize them and identify the factors or forces behind their being in a particular group or category. This explanation gains ground only when existing opportunities of developing human capabilities (such as education, employment opportunities etc.) and institutional interventions will be thought to be unchangeable in *char* areas. If we look at the normal flow of their lives in the typical *char* area or the way they lead their lives as a rule, we see frequent fluctuation of the economic condition of the moderate and extreme poor. Here, using the

concept of poverty line, the effort has been made to categorize the moderate and extreme poor based on the factors responsible for the fluctuation of their economic condition. The moderate and extreme poor live in a place where socio-economic, physical, psychological and environmental forces make them stumble over the way of improving their economic condition. On the other hand, they may be benefited from those forces. For example, flood may bring enough sands instead of silt on land. It has two-way results. A farmer having enough land can be turned into a hardcore poor at any time. Again, he can be benefited provided flood comes with silt.

People, in *char* area, make effort to improve their economic condition. In this process, everybody's ability can not be the same. This ability can be increased or decreased by the influences of these forces or factors.

In this study, the moderate and extreme poor have been further divided into two categories based on their socio-economic conditions which enable (ability) them to improve their economic conditions. They are:

(A) Steady Poor: It refers to those whose economic condition neither improves nor declines. All the year they tried hard to ensure two square meals. During the period of scarcity of work, they cope with the difficulties by dint of the money they borrow from formal and non-formal sources.

Reflection: 1

I am Sadi. I am a day labourer. I am to bear expenses of my family consisting of 5 members. Most often, I migrate in Rajshahi, Dhaka, Tangail and other towns in search of work. My wife is also engaged in homestead gardening and poultry rearing. Thus, we pass our days somehow. We have no savings. Housing condition is very poor. I am to borrow money to bear expenses for treatment, repairing house, and food especially, during the period of flood when there is scarcity of work .At this time, I can neither migrate nor sell labour. I am to stay at home for safety. I have been trying to change my lot but failed over and over again due to flood, river erosion, sickness etc. I had to resettle three times. Resettlement makes us helpless psychologically, physically and financially. Even we are to build house on other's land.

Source: Interview taken by Shafique Place: North Nouhata Char: Sthalnouhata, Upazila: Chouhali, Zillla: Sirajgonj, Date: 26/02/2006

Their savings are not savings in the sense that they are to pay back their credit with that savings. Their savings are for maintaining their existence. The people belonging to this category have no such capital as to develop their living standard above a certain level. They live below the poverty line. The above mentioned statement in the box reflects how a steady poor is affected by various forces.

(B) Unsteady poor: Their position is above the poverty line. It refers to the poor whom their socio-economic condition enables to improve their economic condition to a certain level. Again, unsteady poor can be classified into two groups based on the nature of fluctuations of their economic condition.

i. Improving Poor: It refers to the people whose economic condition is on the upturn and their economic condition can be improved until it reaches that certain level. The statement in the box below reflects how a declining poor is affected by various forces.

Reflection: 2

I am Khadem Ali. I lead a family consisting of 5 members. In the past, I was the only earning member of my family and worked in other's land. Now I own 46 decimals of land. I managed the money to buy it by saving and borrowing and by selling a tiny land owned by my father in another char. Now I am working in my own land besides sharecropping other's land. My wife engaged in earthwork, homestead gardening and poultry rearing. My son has been adult and engaged in small business. Now my economic condition is much better than it was in the past and we are not to pass days with severe hunger like blazing coal.

Source: Interview taken by Shafique Place: North Nouhata Char: Sthalnouhata, Upazila: Chouhali, Zila: Sirajgonj, Date: 26/02/2006

Reflection: 3

My name is Fazlu Miagh. In my family, there are six members including my old mother. Three years ago, I have lost 132 decimals of cultivable land due to river erosion. This year, I have cultivated only 48 decimals of land and got not a good harvest because of flood. I am the only person to earn in my family. Moreover, I borrowed a good amount of money for the marriage of my elder daughter. Now I am suffering form high indebtedness. It is becoming harder day by day to have tow square meals for my family. I have decided to engage my 12 year old son in working in a rich family as servant.

Source: Interview taken by Shafique Place: North Nouhata Char: Sthalnouhata, Upazila: Chouhali, Zila: Sirajgonj, Date: 26/02/2006

ii. Declining Poor: It refers to those whose economic condition is getting worse. An improving poor turns into a declining poor provided his or her economic condition starts fluctuating and can not reach that certain level above the poverty line. The statement in the box below reflects the picture of a declining poor.

Now let us make an effort to analyze steady, improving and declining poor in a visualized way that may help us to understand promptly the real picture of the poor in *char*-areas.

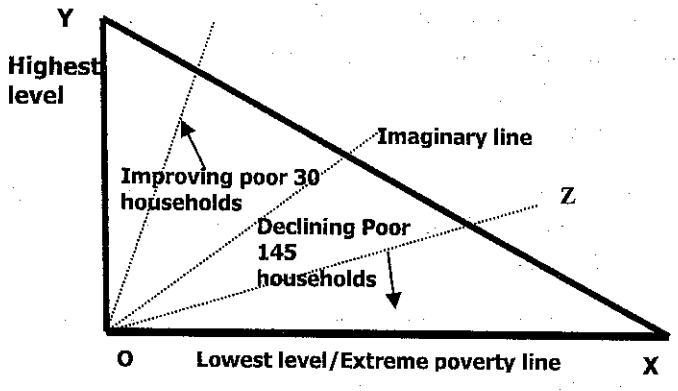

Fig- 2: Dynamics of poverty

In the figure above, OX line shows the lowest poverty level. It indicates such socio-economic condition as provides no opportunity of improving one's economic condition. We have met a lot of people who could not improve their living standard within 15-20 years. They live below the poverty line.

OY line indicates the highest level of improved economic condition. If a person's economic condition happens to improve, it may reach that highest level but not beyond that level. However improving or declining economic condition a steady poor may have, his or her position must be within the range OXY created by OX line and OY line. OZ line has been imagined to be a line or starting point from which economic condition starts improving or declining. This imaginary line can exist at any place within the OXY range.

Now it is important to explore what difference we will find between a poor living in the lowest level and a poor who has reached the highest level. The difference can be best explained with the help of a basic needs fulfillment scale. The poor living in the lowest level can fulfill 40-50% of their basic needs i.e. out of 5 basic needs, they somehow meet the first two needs---- food and clothes and very little can they meet the rest of the needs (residence, education and treatment).

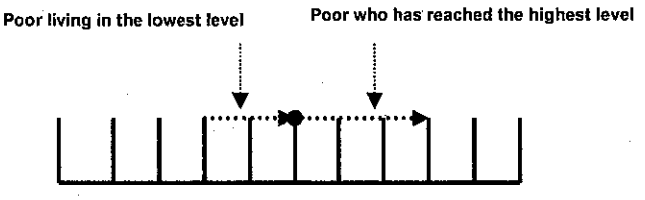

Fig- 3: Basic needs fulfillment scale

The figure shows that the poor who has reached the highest level can meet 60-80% of their basic needs i.e. the first three basic needs- foods, clothes and residence moderately well and the rest of the needs by some means. The most marginalized and disadvantaged people (who can meet 40-50% of their basic needs) who have very little human, financial and land capital and who are experiencing natural calamities such as flood, cyclone, displacement, can not uplift their economic condition beyond a certain level very reasonably and practically. Their economic development tends to fluctuate within a range and most of them can not get stability.

A healthy curiosity about the poor is what factors are responsible for their being steady, improved and declined. The factors are as follows:

A) Factors responsible for being steady: Indebtedness is the only one factor which affects the steady poor severely. All the year they tried hard to ensure two square meals. During the period of scarcity of work, they cope with the difficulties by dint of the money they borrow from formal and non formal sources. Their savings are not savings in the sense that they are to pay back their credit with that savings. Their savings are for maintaining their existence.

The people who belong to this category have no such capital as to develop their living standard above a certain level. They are surviving with hardships in an environment where there are inevitable sufferings of natural hazards, socio-economic and educational backwardness and where basic needs are not fulfilled in the least.

B) Factors responsible for improving economic condition: There are three factors for improving economic condition. These are:

i) Savings: They must have savings. (It has been found that they can save only because there is more than one member in the family contributing to the family income. Except their savings, they can invest if they are financially helped by their relatives, friends or any organization).

ii) Investment: They must have invested it in potential sectors like cattle rearing or cultivating land or small business.

iii) Ability to cope: They must not face or must have ability to cope with any unexpected loss in the invested sectors caused by natural disaster, stealing, accident, disease, massive loss in business etc.

C) Factors responsible for declining economic condition: There are two factors affecting the poor for declining their economic condition.

i) Inability to cope: They have no ability to cope with any unexpected loss in the invested sectors caused by natural disaster, stealing, accident, disease, massive loss in business etc.

ii) Social causes: If a member of a family who contributes to the family income begins to live separately because of his or her marriage, it affects the family in two ways. First, family income decreases to a lesser extent. Second, the family loses a worker who might look after cattle rearing, or play an important role in the economic or domestic activity. Thus, a family, having lost a member of the family, becomes unable to improve the economic condition. More often the family under these circumstances can not even retain their previous condition. Consequently, their economic condition happens to decline.

Another important factor that can be attributed to their declining economic condition is dowry system. The amount of money to be paid as dowry is often managed by borrowing money on higher rate of interest. As a result, being unable to bear this burden of credit, he or she sells their land or cattle which might have been improving their condition.

Conclusion

It has been found from the pie chart drawn by the *char*-dwellers that only 2% people are well off, 6% belong to middle income group, 70% are moderate poor and 22% are extreme poor The way char-dwellers were categorized by themselves does not reflect the real picture nor do direct calorie intake and food energy intake, nor any other poverty line portray the real face of poverty. But we need to categorize them meaningfully before any action is taken to help them. What are at the core of their poverty are various socio-economic, social, mental and economic forces which affect them positively or negatively throughout the year. In *char* areas, people invest their ability to fight against their poverty and to improve their economic condition. But this ability is affected by their social, mental, economic and environmental factors. Thus, this ability may be strong or weak and their economic condition may be improved or declined as such. Based on the views of *char*-dwellers, these interacting forces behind their poverty should be taken into account for any policy and project formulation to fight poverty in the *char*-lands.

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Impact of Deforestation on Environment: A Study on The Dharmapur Sal Forest of Dinajpur

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Abstract

This paper discusses the impact of deforestation on environment at the Dharmapur Forest Bit under Biral upazila in Dinajpur. The study addressed three particular areas namely soil, micro-climate and biodiversity. Soil samples were collected from four different areas for identifying the variation in physical and chemical characteristics of the soils of these areas. A field survey that involved focus group discussion (FDG) with local respondents was done to prepare a comprehensive checklist of flora and fauna and the rate of disappearance of biodiversity was marked using the Bangladesh IUCN Method. A clear-cut difference was discovered between forested and deforested areas due to deforestation. The percentage of sand in the reserve forest (39.55%) was less than the timber monoculture (44.10%), cultivated land (68.22%) and deforested fallow land (70.86%), but the percentage of silt and clay in the reserve forest was more than the aforesaid areas. The pH value of the soil of reserve forest was 5.8 and that of deforested fallow land was 1.3 that indicates the soil of reserve forest was less acidic than the deforested fallow land. The variation of diurnal temperature in forest area (7.0°C) was smaller than that in a deforested land (10.1°C). Both flora and fauna in the Dharmapur forest was threatened by the loss of natural habitat resulting from the increasing the rate of deforestation. The paper concludes if the present trend of deforestation is not checked, the study area may turn into a barren land in near future.

Key words: deforestation, *Sal* forest, biodiversity, flora, fauna, Dinajpur.

1. Introduction

Forest is a renewable natural resource in the terrestrial ecosystem in terms of both economical and environmental importance (MoEF, 2001). This natural resource covers approximately 9.4% of the earth's surface (or 30% of total land area) and functions as habitats for organisms, hydrologic flow modulators, and soil conservers constituting one of the most important aspects of the earth's biosphere (Wikipedia, 2008). In case of tropical rain forests, the area covers about 14% of the earth's land surface but they are exceptional in the wealth of biodiversity. Nearly half of all vertebrates, 60% known plant species and possibly 90% of the world's total species occur in the tropical rain forests.

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Bangladesh is one of the poorest countries in the world in terms of forest resources. The total area under forest is estimated to be 2.52 million ha (see *Table 1*) which in about 17% of the total land area (Bangladesh Forest Department, 2001). Throughout the country the forestlands are largely devoid of adequate natural cover, except negligible forest pockets, to converge plants and other biodiversity. The Government of Bangladesh (GoB) has declared a number of protected areas throughout the country. However, a vast majority of land designated as forests is without tree cover. Most of the protected areas are not properly managed due to lack of proper implementation or enforcement of existing rules, as well as inadequate facilities (Ahmed *et al.* 1994).

Table-1: **Forest Areas in Bangladesh**

Forest Type	Area (in hectares)
Evergreen forest	670,000
Deciduous forest	123,000
Natural mangrove forest	601,700
Coastal and forested mangrove forest	130,000
Village forest	270,000
Social forest	40,000
Tea gardens	70,000
Total forestland	2,600,000

(*Source:* Bangladesh Forest Department, 2001)

In the past three decades, the stock of forest trees has declined at an alarming rate. Though a current forest inventory is unavailable, it is estimated that the forest cover has been reduced more than 50% since 1970s. Estimates in 1990 revealed that Bangladesh had less than 0.02 ha of forestland per person – one of the lowest forests to population ratios in the world. Presently less than 8% of the country is under forest cover (Islam *et al.* 2000). Depletion of natural forests in Bangladesh, at the rate of 3.3% per year, is highest in Asia and the Middle East and the third highest in the world after Haiti and Jamaica. Increasing population and landlessness, conversion of forest land to various competing uses, illegal logging of state forests, logging for fuel wood by rural people for subsistence, and over-exploitation have led to the depletion of forest resources of the country (BBS, 2005).

Though deforestation is happening throughout the country but the *Sal* forests are more vulnerable situation because of their size and scattered distribution. The traditional *Sal* forests are distributed in the Madhupur Tract, Lalmai Hills and some parts of Barind Tract, as well as in the districts of Dhaka, Gazipur, Mymensingh, Tangail, Sherpur, Comilla, Rangpur, Dinajpur, Thakurgaon, Panchagarh, Gaibandha, Lalmonirhat and Naogaon. In the *Sal* forests, 70-75% of the trees are *Sal*

and the soil looks yellowish-red colour. Ghani and Steven (1990) classified the tropical moist deciduous *Sal* forests of Bangladesh into – moist *Sal* forests and *Sal* scrub forests. The moist *Sal* forests are the areas containing *Sal* trees as pure crop, mostly of coppice origin. On the other hand, the *Sal* scrub forests are results of repeated human interference, which are also termed as 'deforested *Sal* forests'.

Most of the *Sal* forests have been denuded, degraded and encroached upon by people or used for plantation of rubber monoculture and mostly exotic commercial fuel-wood species. The demand for *Sal* and forest products seems unlimited. Even though now the supply has decreased drastically, *Sal* trees including the stumps are still used as fuel in brick kilns and industry. (MoEF, 2001)

Deforestation is the cause of environmental degradation and people's vulnerability. There are a lot of studies done to identify the impact of deforestation on environment. Deforestation is often cited as one of the major causes of the enhanced greenhouse effect. Deforestation can cause the destruction of the habitats that support global biodiversity, the scarcity of water including groundwater, increasing soil erosion, changing local climate and occurring several disasters i.e. landslides, floods.

Banglaqdesh is facing a lot of economic and environmental crises due to deforestation. The cost of these impacts on the economy was estimated at one percent of GDP in 1990 (BBS, 2005). In case of environmental problems, biodiversity is threatened by the loss of habitat resulting from increasing deforestation. According to the Red List of IUCN (2000), 54 species of inland fishes, 8 amphibians, 58 reptiles, 41 resident birds and 40 mammals are threatened throughout the country.

As elsewhere in the country, *Sal* forests of Dinajpur have also been degraded. There is considerable evidence to assume that as much as 50% of *Sal* forests may have been cleared (Byron, 1985). There is 2,729.36 acres of forestland under the control of the Forest Department in Biral upazila but, in reality, over 50% of the forest cover has been destroyed (DFBO, 2002) and the impacts of deforestation in this area have not been studied yet.

2. Objectives

The aim of the study was to describe and understand the impacts of deforestation on environment in the *Sal* forest area of Dharmapur of Birol Upazila under Dinajpur district. Keeping this aim in view the specific objectives of the study were set as follows:

i. Discover people's perception on impact of deforestation

ii. Identify the change in the characteristics of soil due to deforestation

iii. Measure the change in micro-climatic situation, and

iv. Prepare a checklist of the local biodiversity.

3. Methodology

The study was conducted at Dharmapur *Sal* forest bit under Biral upazila in Dinajpur district. The selection of the site was made considering cost affordability, easy communication linkage, and friendliness of the local people.

The study has made good uses of both primary and secondary data. The original information collected for the study was primarily based on direct observation, field sampling, laboratory tests and focus group discussion (FGDs) with the local residents. Considerable data gathered from the secondary sources were utilized in addition. Secondary sources were mostly official documents and records, journals, books, etc. As a matter of fact, a thorough search was done in the libraries of government and semi-government institutions including different universities.

To see the impact of deforestation at the soil health level, samples of soil were collected from four different sites of the study area (each having three samples) and analysed for physical and chemical properties. The four different sample sources were reserve forest, timber monoculture, cultivated land and deforested fallow land. Samples were obtained from two different depths, topsoil (0-5 cm) and sub-surface soil (30-35 cm). Different scientific methods were used to determine the change in physical and chemical properties of soil (see *Box 1*).

Box 1: Methods Used in Soil Analysis

Soil moisture-holding capacity	: Gravimetric Method
Soil texture (sand, silt and clay)	: Mechanical Analysis of Bouyoucos Hydrometer Method
Soil pH value	: pH Meter (Model pH 530)
Organic matter	: Walk-leys and Black's Wet Oxidation Method
Nitrogen	: Micro-Kjeldahl's Method
Phosphorus	: Molybdate Stannous Chloride Method
Potassium	: Solution of Ammonium Acetate

Temperatures of the interior and exterior of the forest were taken four times at a six hours interval in a day. Later on, the variation of diurnal temperature was measured by using mathematical tool. Direct observation and FGDs were conducted using a checklist of both present and past flora and fauna. Then the rate of disappearance of biodiversity was identified by using the 'Global Threatened IUCN Method' (see *Figure 1*).

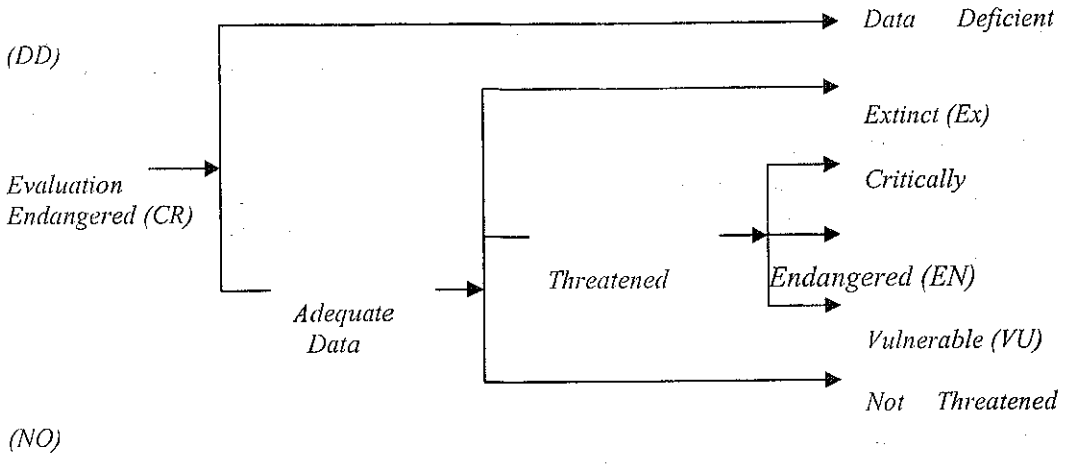

Figure 1: Structure of the Bangladesh National Categories IUCN Method

During FGD, the respondents firstly prepared lists of different flora and fauna of the study area. Then they deducted those flora and fauna whose data they did not know. Further they divided the rest of the flora and fauna into three categories namely extinct, threatened and not threatened. Finally threatened flora and fauna were classified into three categories again based on the level of threat – critically endangered, endangered and vulnerable.

4. Results and Discussion

4.1. People's Perception on Impact of Deforestation

Local people predicted there were severe impacts on local environment due to deforestation. They guessed those impacts which they often saw or felt.

Table-2: **Major Impact of Deforestation on Environment**

Impacts	Rate of Responsibility (%)		
	High	Medium	Low
Extinction of biodiversity	100	-	-
Increasing temperature	76	16	8
Decreasing rainfall	52	24	24
Decreasing underground water	44	44	12
Decreasing soil fertility	44	40	16
Erosion of highland	20	40	40
Others	16	32	52

(*Source*: FGD, 2003)

Table- 2 summarises the impacts of deforestation on environment. All respondents agreed that biodiversity of the area was at risk. More than three-fourths of respondents (76%) have shown their severe anxiety over increasing temperature. Data show around half of the respondents have expressed their concern about the rainfall which is declining, availability of underground water and soil fertility are also decreasing gradually. Besides, few respondents (16%) have said that erosion of highland has become another problem due to deforestation. Findings obtained from the respondent ordinary almost similar to what scientists have found out regarding the overall impact of deforestation.

4.2. Variation in Soil Characteristics of Different Areas

Soil samples were collected from four different land use areas namely reserve forest, timber monoculture (mainly eucalyptus and acacia), cultivated land and deforested fallow land. Three samples were collected from each area. Samples were obtained from two different depths, such as – topsoil (0-5 cm) and subsurface soil (30-35 cm).

4.2.1. Physical Properties of Soils

Soil Moisture-holding Capacity

Soil moisture is one of the most conspicuous factors. Besides its direct influence on the growth of plants, the amount of soil water predetermines a number of other important soil conditions p.i.e. soil temperature, aeration, micro-biological activity, availability of nutrients and concentration of toxic substances. (Wilde, 1958)

Table -3: **Physical Properties of Soils in Different Areas**

Sample Area	Soil Depth	Moisture-holding capacity (%)	Percentage of Soil Particles			Percentage of Organic Matter
			Sand	Silt	Clay	
Reserve Forest	0-5 cm	11.85	50.33	33.43	16.24	3.00
	30-35 cm	15.13	28.77	33.07	38.16	2.74
Timber Monoculture	0-5 cm	2.97	57.33	32.29	10.44	1.03
	30-35 cm	13.00	30.86	32.58	36.56	1.06
Cultivated Land	0-5 cm	9.86	63.23	21.87	14.90	3.37
	30-35 cm	11.77	73.21	15.50	11.29	2.97
Deforested Fallow Land	0-5 cm	5.36	68.95	18.89	12.16	1.36
	30-35 cm	10.16	72.76	17.28	9.96	1.53

(*Source*: Laboratory Analysis, 2003)

Table-3 shows that soil moisture-holding capacity (11.85% in topsoil and 15.13% in subsurface soil) was the highest in reserve forest area. On the other hand, timber monoculture created a great difference in moisture-holding capacity in topsoil (2.97%) and sub-surface soil (13.0%). It clearly indicates that timber monoculture is reducing soil moisture-holding capacity that threatens different shrubs and herbs including micro-organisms to survive.

The data also reveals moisture-holding capacity of topsoil of cultivated land is considerably higher (9.86%) than that of deforested fallow land (5.36%) though the moisture-holding capacity in subsurface level of both areas are almost similar. However, it was clearly identified that fallow land lost its moisture-holding capacity gradually. To better this ability fallow lands should be reforested again or at least cultivated for different agricultural products rather than establish timber farming through eucalyptus, acacia, and like species.

Soil Texture

Soils include two ecologically important fractions – a coarse fraction (larger than 0.05 mm in diameter, includes stones, gravel and sand) and a fine fraction (smaller than 0.05 mm in diameter, is comprised of silt and clay).

From the data in Table-3 it because obvious that the proportion of sand was lowest in reserve forest land (50.33% in topsoil and only 28.77% in subsurface soil) and highest in deforested fallow land (68.95% in topsoil and 72.76% in subsurface soil). Conversely, proportion of silt (33.43% in topsoil and 33.07% in subsurface soil) and clay (16.24% in topsoil and 38.16% in subsurface soil) was highest in reserve forest area and lowest in deforested fallow land (9.96% clay in subsurface soil) and cultivated land (15.50% silt in subsurface soil).

The fine particles - clay and silt of the soil is preserved in reserve forest because of dense and extensive network of roots. In case of timber monoculture, the fine particles are washed away from soil by rainfall but sand remains in the soil because of lack of undergrowth plants like shrubs and herbs. Moreover, silt and clay undergo quick erosion by means of rain and wind, as a consequence, the proportion of sand increases in deforested fallow land.

Organic Matter

Among its numerous functions, soil organic matter exerts a purely physical influence supplementing that of mineral colloids. Organic matter increases considerably the water-retaining capacity of soils. It has also the ability to retain nutrients, particularly bases and ammonia. (Wilde, 1958)

Data reported in Table-*3 show* that the amount of organic matter (3.17%) was highest in cultivated land because these lands are being cultivated continuously. Organic manures and fertilizers are also applied to achieve high yield from crops. The amount of organic matter was found also considerable (2.87%) in reserve forest soil because leaves fallen from trees and undergrowth plants after their death became decomposed with soil, thereby, increased amount of organic matter. In case of deforested fallow land, quantity of organic matter was little (1.45%) because of

lack of plant cover. Moreover, the quantity of organic matter was found the lowest (1.05%) in timber monoculture land because undergrowth plants did not exist under eucalyptus and acacia.

4.2.2. Chemical Properties of Soils

The pH Value

The pH value exerts a definite influence upon the life functions of organisms, availability of nutrients and physical properties of soils. The smaller value of pH (less than 7) and its greater value (more than 7) represent the acidity and the alkalinity of soil, respectively.

Table 4: **Chemical properties of Soils in Different Areas**

Sample Area	Soil Depth	pH Value	Percentage of Nutrient Elements		
			N	P (ppm.)	K
Reserve Forest	0-5 cm	5.7	0.21	20	2.6
	30-35 cm	5.9	0.22	20	2.6
Timber Monoculture	0-5 cm	4.0	0.07	7	0.8
	30-35 cm	4.4	0.07	7	0.9
Cultivated Land	0-5 cm	6.0	0.27	26	3.1
	30-35 cm	6.2	0.27	26	3.1
Deforested Fallow Land	0-5 cm	1.3	0.13	9	1.4
	30-35 cm	1.4	0.13	10	1.5

(*Source*: Laboratory Analysis, 2003)

N.B. N = nitrogen, P = phosphorus, K = potassium

From *Table-4* it is evident that the average pH values of the soil of cultivated land, reserve forest and timber monoculture were 6.1, 5.8 and 4.2, respectively. On the other hand, the pH value of the soil of deforested fallow land was considerably low (1.35), meaning that the soil of this area was acidic which is unfit for reforestation or even for cultivation within few years.

Essential Nutrient Elements

Nutrients fulfill numerous physiological functions in the development of plants.The study has addressed three major elements - nitrogen, phosphorus and potassium. From the *Table 4* it is obvious that the amount of nitrogen (0.27%), phosphorus (26 ppm.) and potassium (3.1%) was highest in cultivated land. It is because that chemical fertilizers and insecticides are applied here continuously to increase were yields of crops. These nutrient elements(N 0.22%, P 20 ppm. and K 2.6%) were also found in ample amount in reserve forest land but the availability of these elements (N 0.07%, P 8 ppm. and K 0.9%) was lowest in timber monoculture land.

4.3. Micro-Climatic Change

It is not possible to determine the micro-climatic change without dense forest especially rainfall-related data were not visible in the study area in such a small and scattered forest bit. However, there was a little difference in temperature observed at different times in a day both inside and outside the forest.

Table 5: **Variation of Diurnal Temperature (°C) Inside and Outside of the Dharmapur Forest Bit**

Sample Area	Temperature (°C)				Average Temperature	Variation of Temperature
	6 am	12 pm	6 pm	12 am		
Inside	18.6	23.8	19.4	16.8	19.65	7.0
Outside	18.0	25.6	20.2	15.5	19.83	10.1

(*Source*: Field Survey, 2003)

Table -5 shows that temperature of the inferior of the forest at 12 0'clock at midnight (16.8°C) and 6 o'clock (18.6°C) in the morning was higher than that of outside of the forest (15.5°C and 18.0°C respectively). On the other hand, temperature of inside area at 12 o'clock at noon (23.8°C) and 6 o'clock in the evening (19.4°C) was lower than that of outside area (25.6°C and 20.2°C, respectively). In daytime sunlight reaches directly outside of forest but it cannot enter properly inside forest area. So, the daytime temperature of the outside of forest area is usually higher than that of the inside of forest. Conversely, at night earth can release her temperature captured in daytime but inside forest, heat cannot exit for high density of trees. However, average temperature of inside of forest (19.65°C) was slightly lower than that of outside of forest (19.83°C) but the variation of diurnal temperature inside of forest (10.1 °C) was 3.1 °C higher than that of outside area (7.0 °C). Therefore, forest made its surrounding area cooler compare with the deforested area.

4.4. Impact on Biodiversity

The condition of biodiversity of the study area is at risk due to deforestation. Many species have already disappeared or in the process of extinct. Though the main species of the forest is *'Sal'* but a lot more other species of flora were found there. Not only deforestation but also timber monoculture is changing the characteristics of soil. As a result, various undergrowth species and wild animals have disappeared. *Table-6* and *Table-7* show the rate of disappearance of various species of flora and fauna as derived through 'Bangladesh National Categories of IUCN' method.

4.4.1. Flora

It is evident from the *Table-6* that trees, shrubs, herbs and climbers species have been regarded as the flora of this forest. With the exception of some plants i.e. *sal*, sisso, eucalyptus and acacia, almost every other species is threatened to some extent. The respondents have not been able to give important information as regarding shrubs, herbs and climbers. But since these types of plants

are somehow dependent on larger trees, these will soon be extinct with destruction of the forest. The economic uses of these plants given in the checklist are likely to show how important these plants are in our daily life and how far they can be helpful for our life and livelihood.

***Table 5:* A List of Endangered Flora in Dharmapur Forest Bit**

	Extinct	Critically Endangered	Endangered	Vulnerable	Not Threatened	Data Deficient	Total
Trees	8	6	5	8	9	8	44
Shrubs	0	0	2	1	5	7	15
Herbs	0	1	1	2	6	5	15
Climbers	0	1	1	2	5	5	14
Total	8	8	9	13	25	25	88

(*Source*: FGD, 2003)

In the study area, eight species of trees are extinct and 19 species of trees, three species of shrubs, four species of herbs and climbers are shown endangered *Table 6.*

4.4.2. Fauna

It is obvious from the *Table -7* that the conditions of animals are much worse than plants of the forest. Amphibians, reptiles, birds and mammals have been taken into consideration in the checklist (*Table- 7*). *Gechho bang* (one kind of frog living on trees) and python are now extinct, and *gecho shap* (one kind of snake living on trees) and *roktochosha* (blood-sucker) are on the verge of extinction. Various species of birds are still on danger. Mammals are now extinct or going to be extinct soon. Wild buffalo, Indian bison, Indian antelope, etc., once found in considerable number, are now completely extinct. Besides, *baghdash*, various species of monkey, wild hog, Indian civet, wolf, swamp tiger, etc. will soon be extinct. However, porcupine, rabbit, mongoose, fox, etc. are still not under substantial threat.

Table 5: **A List of Endangered Fauna in Dharmapur Forest Bit**

	Extinct	Critically Endangered	Endangered	Vulnerable	Lower Risk	Not Threatened	Data Deficient	Total
Amphibians	1	0	0	1	0	1	0	3
Reptiles	2	1	0	1	0	4	2	10
Birds	1	0	0	3	7	1	2	14
Mammals	7	4	1	1	1	2	0	16
Total	11	5	1	6	8	8	4	43

(*Source*: FGD, 2003)

Table 7 shows one species of amphibians and birds both, two species of reptiles and seven species of mammals are extinct, and one species of amphibians, two species of reptiles, 10 species of birds and seven species of mammals are threatened.

It can easily be said from the above findings that the biodiversity of the study area is facing considerable threat as a consequence of deforestation. The only way to keep this biodiversity safe and sound is to preserve the natural forest and also to undertake large scheme projects of afforestation and reforestation so that the natural habitat of the existing flora and fauna will be saved.

5. Conclusion

Deforestation always exerts some negative impacts on environment. The soil characteristics of an area usually depend upon the existence or non-existence of forest in the area. The amount of silt (33.25%) and clay (27.20%) was considerable high and sand (39.55%) was comparatively low in reserve forest area. By contrast, the amount of sand was found to be higher in timber monoculture (44.10%), cultivated land (68.22%) and deforested fallow land (70.86%), but the amount of silt and clay was low. Moreover, the soil of deforested fallow land (pH value 1.35) becames more acidic than the reserve forest (pH value 5.8). The amount of organic matter (3.17%), nitrogen (27), phosphorus (26) and potassium (31) was found very high in cultivated lands because of using various kinds of fertilizers extensively to increase the yield of crops. In case of reserve forest, leaves fallen from trees and undergrowth plants decomposed after their death enhanced organic and chemical properties of soil. On the other hand, magnitude of these properties is very low in timber monoculture and deforested fallow land.

Micro-climatic changes due to deforestation have been observed. The variation of diurnal temperature in the forest area (7.0°C) was smaller than that in the deforested area (10.1°C). Deforestation also exerted negative impact on local biodiversity. Sal forest is a natural entity

where 'Sal' study is the major tree. It grows and provides habitat for other species. The forest area under was full of varieties of flora and fauna in the past, but at present they have decreased drastically. When big trees are cut down, undergrowth plants like shrubs, herbs and climbers dependent on these trees have no other way to survive. In the name of timber monoculture, eucalyptus and acacia threat other small dependent plants, which have multidimensional economic uses including medicinal value. Following deforestation, the forest becomes less dense as a result of increasing anthropogenic activities in and around the forest. Many wild animals, once found in this forest in considerable numbers, have almost disappeared.

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Assessment of Boron Accumulation by Naturally Grown Weeds for the Development of Phytoremediation Technology

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Abstract

A pot experiment was conducted in the net house of the Agricultural Chemistry Department, Bangladesh Agricultural University, Mymensingh during July to November 2003 to identify naturally grown boron hyper accumulating weed species from boron contaminated soil and assessment of boron accumulation by naturally grown weeds for the development of phytoremediation technology. Boron and phosphorus were determined in Barnyard grass, Joina, Water cress, Malancha, Panikachu, Panilong, Chisra and Topapana. The pot experiment was laid out in a completely Randomized Design (CRD) with 13 treatments and two replications. The treatments were 0,0.5,0.75,1.0,1.5,2,4,8,12,20,30,50 and 100 mg BL^{-1}. Nine weed species namely; Barnyardgrass (Echinochloa crus-galli), Joina (Fimbristylis miliacea), Chisra (Scirpus juncoids), Panikachu (Monochoria hastate), Panilong (Luduwigia hyssopifolia), Malancha (Alternanthera philoxeroides), Topapana (Pistia stratiotes) and Water cress (Enhydra fluctuans) accumulate boron in an increasing level of boron treatment except Mutha (Cyperus rotundus). Out of nine weeds Water cress absorbed the highest amount (398.88 μ g pot^{-1}) of boron followed by Malancha (188.67 μ g pot^{-1}), Panikachu (154.15 μ g pot^{-1}), Joina (105.90 μ g pot^{-1}), Barnyard grass (93.02 μ g pot^{-1}), Chisra (74.68 μ g pot^{-1}), Panilong (29.373 μ g pot^{-1}) and Topapana (25.46 μ g pot^{-1}). Although maximum accumulation of boron was found in Water cress, it is not abundant in the rice field, while Joina, Barnyard grass and Chisra are frequently grown. Considering the absorption pattern, biomass and toxicity tolerance, Joina and Barnyard grass are the best performer and can be considered for the mitigation of boron contaminated soil due to irrigation water while Water cress and Malancha can be used for remediation of stagnant boron contaminated water as a means of phytoremediation technology.

Key words: Boron concentration, weeds, assessment of Boron accumulation, phytoremediation technology

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Introduction

Phytoremediation is an emerging technology of today. This green plant based technology holds less residual effect, cost effective and ecofriendly. Soils contaminated with nuclear radiation at Chernobyl, Ukraine in 1986 was mitigated by phytoremediation technology. Iowa city used tree plants to clean landfills in 1989. Nitrogen contaminated aquifers in New Jersey was cleaned by phytoremediation. The groundwater contains different levels of boron. In some cases, a boron level in groundwater exceeds the tolerance limit ($\leq$ 0.75 mg BL^{-1}) for irrigating rice. Irrigation water containing 0.5 mg BL^{-1} can be safely used temporarily but long term use may cause yield reduction, 1 mg BL^{-1} if used for long term would induce B toxicity and disease severity. Water containing 4 mg BL^{-1} if irrigated excessive B would be accumulated in the rice grain and would pose threat to food chain contamination. Since phytoremediation is a holistic approach, it is potential to serve as a sustained, ecologically sound method to remediate contaminated soil and ground water.

Objectives of the trial were two - fold:

1) Identify naturally grown boron hyper accumulating weed species from boron contaminated soil;
2) Assess boron accumulation by naturally grown weeds for the development of phytoremediation technology.

Materials and Method

The experiment was conducted in the net house and in the laboratory of the department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh, from July 2003 to May 2004. The soil was collected from the village of Vabokhali, Sadar Thana, Mymensingh. The initial soil (virgin soil) was collected because this soil was not freaked by any fertilizer. For getting response of Boron, virgin soil was used. The soil had total N=1.15%, $NaHCO_3$ extractable P = 17.901 $mgkg^{-1}$, ammonium acetate extractable K = 0.44 meq/100g soil, ammonium acetate extractable Ca = 3 meq/100g soil and Mg = 4.5 meq/100g soil SO_4-S = 10.41 $mgkg^{-1}$, ammonium acetate extractable Na = 1.65 meq/100g soil, Na_2-EDTA extractable Zn = 3.09 $mgkg^{-1}$ and Cu = 3.08 $mgkg^{-1}$, p^H = 6.9. The initial soil boron content and tap water boron concentration were B = 0.37 $mgkg^{-1}$ and 0.017mg BL^{-1}, respectively (Khan, 2002). The experiment pots were previously treated with 13 boron treatments. The treatments were as follows:

Treatment	Boron concentration	Treatment	Boron concentration
T_0	Control	T_7	8.00 mg BL^{-1}
T_1	0.5 mg BL^{-1}	T_8	12.00 mg BL^{-1}
T_2	0.75 mg BL^{-1}	T_9	20.00 mg BL^{-1}
T_3	1.00 mg BL^{-1}	T_{10}	30.00 mg BL^{-1}
T_4	1.50 mg BL^{-1}	T_{11}	50.00 mg BL^{-1}
T_5	2.00 mg BL^{-1}	T_{12}	100.00 mg BL^{-1}
T_6	4.00 mg BL^{-1}		

The criteria used for selecting plants for phytoremediation were high boron tolerance, high bioaccumulation factor, short life cycle, high propagation rate, wide distribution and large shoot biomass. Exactly, 1g of plant sample was taken into a 250mL. conical flask and 10mL. di-acid mixture (HNO_3: $HClO_4$ = 2:1) was added. The flask was placed on the electric hot plate for heating at 180-200°C until the solid particles nearly disappeared and white fumes were evolved from the flask. It was cooled at room temperature, washed with distilled water repeatedly and filtered into 100mL. volumetric flask through Whatman No. 42 filter paper and the volume was made up to the mark with distilled water. The grain and straw extracts were preserved separately in plastic bottles for the analysis of plant nutrients (Jackson, 1967). The concentration of sulphur in the extract was estimated turbidimetrically with the help of a spectrophotometer set at 420nm wave length (Wolf, 1982). Phosphorus was estimated colorimetrically (taking stannous chloride as reductant) with the help of spectrophotometer (Spectronic 21D) set at 660 nm wave length (Jackson, 1967). Boron (B) was determined by Azomethine-H method. The absorbance was recorded at 420nm wave length (Page *et al.*, 1982). The analysis of variance for the nutrient content of grain, straw and soil were done following the principle of statistics and the mean results in case of significant F value were adjudged by the Duncan's Multiple Range Test (DMRT) as outlined by Duncan (1951) with the help of a computer package M-STAT. The criteria used for selecting plants for phytoremediation were high boron tolerance, high bioaccumulation factor, short life cycle, high propagation rate, wide distribution and large shoot biomass.

Results and Discussion

1. Concentration of Boron in weeds under different treatments

The accumulation of boron was gradually increased with the increasing boron supply treatments. In case of Chisra, the highest boron accumulation (18.12 ppm B) was observed at T_{100} treatment and the lowest (0.33ppm B) was against the T_0 treatment. Barnyardgrass showed the highest accumulation of boron (22.398 ppm) at T_{100} treatment. In case of Malancha, the highest concentration of boron was found against 100 ppm where the lowest (3.79 ppm) was in T_0 treatment. In Topapana, the highest concentration of boron (7.25) was obtained in T_{100} and the lowest (0.83ppm) was at T_0 treatment. In case of Water cress, the concentration of boron varied from 3.49 to 16.86ppm. The highest concentration of boron was recorded in the treatment T_{100} (100 mg BL^{-1}). In Panikachu, concentration of boron was increased with the increasing rate of boron levels and ranged from 1.32 to 16.26 ppm. In case of Joina, the highest concentration of boron (17.46 ppm) was found in T_{100} treatment and the lowest concentration of it (3.68 ppm) was against T_0 treatment. In Panilong, the concentration of boron ranged from 1.81 to 9.75 ppm while the highest boron concentration (9.75 ppm) was recorded in the T_{100} treatment.

Table 1. Concentration of boron in weeds (ppm B)

Treatment	Chisra	Barnyard grass	Malancha	Topapana	Water cress	Panikachu	Joina	Panilong
T_0	0.33i	6.26g	3.79g	0.83e	3.49j	1.321	3.68h	1.81d
$T_{0.5}$	2.31h	6.78g	6.39f	1.81d	4.98i	2.03k	4.73g	2.31d
$T_{0.75}$	3.49g	7.73fg	7.25f	4.60c	7.27h	2.81j	7.89f	4.15c
$T_{1.0}$	3.75g	9.22ef	9.16e	4.60c	9.73g	3.10i	12.73e	4.33c
$T_{1.5}$	3.79g	9.75e	9.22c	4.60c	9.79g	3.50i	13.68de	4.60c
$T_{2.0}$	3.95g	10.21e	10.50dc	4.60c	10.71f	5.28h	14.03cd	4.60c
$T_{4.0}$	6.69f	10.42e	10.54dc	4.60c	11.98e	6.28g	14.81bc	4.60c
$T_{8.0}$	8.80e	12.31d	11.02d	4.78c	13.31d	8.46f	15.05bc	4.60c
$T_{12.0}$	11.69d	15.27c	14.49c	4.78c	14.99c	11.20e	15.18b	4.60c
$T_{20.0}$	13.24c	16.34c	15.04c	4.78c	15.34bc	12.68d	15.37b	7.25b
$T_{30.0}$	17.13b	18.12b	17.46b	6.26b	16.28ab	13.30c	16.97a	8.65a
$T_{50.0}$	17.91a	19.11b	18.12b	7.05a	16.78a	14.15b	17.46a	8.83a
$T_{100.0}$	18.12a	22.39a	22.40a	7.25a	16.86a	16.26a	17.46a	9.75a
Level of significance	**	**	**	**	**	**	**	**
CV (%)	2.47	5.60	5.58	5.96	4.86	3.36	3.52	9.57

*Source: Pot Experiment 2003-2004. ** Significant at 1% level of probability. In a column figures showing dissimilar letter(s) differ significantly according to DMRT.*

Subedi *et al.* (1997) also expressed similar views that concentration of boron increases in plant tissue with the increasing levels of application. It was evident that plant barrier of B accumulation by Chisra and Panilong failed at 2 mg BL^{-1} and 12 mg BL^{-1} respectively. Consequently B entered increasingly into the plant system.

2. Effect of boron on the concentration of phosphorus in different weeds

Results presented in table 2 indicate that the accumulation of phosphorus by weeds increased with increasing rate of added boron. In case of Chisra, the accumulation of phosphorus ranged from 0.89% to 0.385% and the highest phosphorus was recorded at T_{100} treatment. In Barnyard grass, the highest concentration of phosphorus (0.379%) was obtained in T_{100} treatment. In case of Malancha, phosphorus concentration varied from 0.105% to 0.239% while the highest concentration of phosphorus was obtained in T_{100} treatment. The phosphorus concentration of Topapana, Water cress, Panikachu, Joina, Mutha, Panilong ranged from 0.116 to 0.587, 0.189 to 0.368, 0.203 to 0.659, 0.119 to 0.319, 0.076 to 0.363 and 0.35 to 0.439%, respectively.

Table 2. Concentration of phosphorus (mg%)

Treatment	Chisra	Barnyard grass	Malancha	Topapana	Water cress	Panikachu	Joina	Mutha	Panilong
T_0	0.89a	0.099h	0.105f	0.116e	0.189f	0.203j	0.119i	0.076h	0.035j
$T_{0.5}$	0.128h	0.177g	0.136e	0.140e	0.245e	0.267i	0.140hi	0.098g	0.46ij
$T_{0.75}$	0.170gh	0.229f	0.149e	0.167e	0.259e	0.279i	0.149gh	0.117fg	0.059hi
$T_{1.0}$	0.190f-h	0.248ef	0.154e	0.267d	0.268d	0.318h	0.165fg	0.126f	0.076h
$T_{1.5}$	0.198f-h	0.275de	0.176d	0.280cd	0.275d	0.399g	0.172f	0.136f	0.098g
$T_{2.0}$	0.218e-g	0.267de	0.189cd	0.286cd	0.286cd	0.416g	0.178ef	0.179e	0.105g
$T_{4.0}$	0.237e-g	0.289d	0.199bc	0.297cd	0.298c	0.446f	0.199de	0.195e	0.116fg
$T_{8.0}$	0.256d-f	0.317c	0.216ab	0.339b-d	0.326b	0.489e	0.207cd	0.239d	0.129ef
$T_{12.0}$	0.276c-e	0.317c	0.216ab	0.346bc	0.336b	0.529d	0.218cd	0.256cd	0.146e
$T_{20.0}$	0.287c-e	0.327bc	0.220ab	0.376b	0.341b	0.567c	0.206cd	0.249cd	0.187b
$T_{30.0}$	0.317b-d	0.319c	0.223a	0.389b	0.345b	0.589b	0.229bc	0.267bc	0.267c
$T_{50.0}$	0.345bc	0.345b	0.230a	0.524a	0.349ab	0.659a	0.246b	0.287b	0.318b
$T_{100.0}$	0.385b	0.379a	0.239a	0.587a	0.368a	0.659a	0.319a	0.363a	0.439a
Level of significance	**	**	**	**	**	**	**		**
CV (%)	10.08	4.02	4.29	8.03	5.81	4.38	4.48	5.21	3.78

*Source: Pot Experiment 2003-2004. ** Significant at 1% level of probability. In a column figures showing dissimilar letter(s) differ significantly according to DMRT.*

3. Effect of boron on the concentration of sulphur in different weeds

The accumulation of sulphur in different weeds significantly decreased by increasing doses of boron. The sulphur concentration of Chisra, Barnyard grass, Malancha, Topapana, Water cress, Panikachu, Joina, Mutha, Panilong ranged from 0.055 to 0.287%, 0.078 to 0.3.2%, 0.027 to 0.175%, 0.067 to 0.485%, 0.040 to 0.353%, 0.067 to 0.424%, 0.039 to 0.380%, 0.047 to 0.346% and 0.026 to 0.165%, respectively (Table 3). Highest amount of sulphur (0.485%) was found in Topapana against T_0 (control) treatment. Increasing doses of boron might have been involved in reducing the accumulation of sulphur.

Table 3. Concentration of sulphur (mg%)

Treatment	Chisra	Barnyard grass	Malancha	Topapana	Water cress	Panikachu	Joina	Mutha	Panilong
T_0	0.287a	0.302a	0.175a	0.485a	0.353a	0.424a	0.380a	0.346a	0.165a
$T_{0.5}$	0.267ab	0.289a	0.113b	0.389b	0.269b	0.399b	0.367a	0.282b	0.113b
$T_{0.75}$	0.249b	0.224b	0.096bc	0.376b	0.269b	0.382bc	0.356ab	0.249c	0.113b
$T_{1.0}$	0.249b	0.203bc	0.096bc	0.309c	0.189c	0.376c	0.342a-c	0.180d	0.101bc
$T_{1.5}$	0.149cd	0.198c	0.076cd	0.289cd	0.189c	0.339d	0.326a-c	0.167d	0.095bc
$T_{2.0}$	0.156c	0.176d	0.069de	0.276d	0.146d	0.316e	0.308a-c	0.159d	0.079cd
$T_{4.0}$	0.129de	0.127e	0.059d-f	0.198e	0.119e	0.289f	0.287bc	0.116e	0.067de
$T_{8.0}$	0.116ef	0.119ef	0.050e-g	0.157f	0.102ef	0.265g	0.269c	0.102ef	0.052ef
$T_{12.0}$	0.103f	0.114ef	0.049e-g	0.118g	0.093fg	0.198h	0.197d	0.098ef	0.045e-g
$T_{20.0}$	0.101f	0.105ef	0.052ef	0.105gh	0.078gh	0.129i	0.106e	0.081fg	0.039fg
$T_{30.0}$	0.098f	0.105ef	0.045fg	0.096gh	0.059gi	0.106j	0.087e	0.067gh	0.034fg
$T_{50.0}$	0.076g	0.097fg	0.039fg	0.086hi	0.046i	0.096j	0.053e	0.059gh	0.030fg
$T_{100.0}$	0.055g	0.078g	0.027g	0.067i	0.040i	0.067k	0.039e	0.047h	0.026g
Level of significance	**	**	**	**	**	**	**	**	**
CV (%)	5.01	7.16	12.04	14.96	11.08	4.52	13.09	10.44	15.95

*Source: Pot Experiment 2003-2004. ** Significant at 1% level of probability. In a column figures showing dissimilar letter(s) differ significantly according to DMRT.*

4. Apparent boron recovery

An attempt was made to compute the amount of boron uptake by weeds and the amount of boron remained in the soil after this experiment. It is evident from Table 4. that the total boron uptake by Water cress, Malancha, Panikachu, Joina, Barnyard grass, Chisra, Panilong and Topapana ranged from 41.89 to 398.88 μ g pot^{-1}, 103.46 to 188.67 μ g pot^{-1}, 37.29 to 154.15 μ g pot^{-1}, 19.03 to 105.90 μ g pot^{-1}, 11.22 to 93.02 μ g pot^{-1}, 9.42 to 74.68 μ g pot^{-1}, 2.662 to 29.37 μ g pot^{-1} and 5.12 to 25.46 μ g pot^{-1}. The concentration of hot water extractable boron in post harvest soil of Chisra, Barnyard grass, Malancha, Topapana, Panikachu, Joina, Mutha, Panilong ranged from 0.336 to 9.73, 0.83 to 15.73, 0.553 to 18.12, 0.23 to 10.62, 2.31 to 15.16, 3.30 to 23.06, 2.31 to 13.24, 073 to 18.12 and 1.82 to 10.46 mg B kg^{-1} (Table 5). Highest amount of boron (23.06 mg B kg^{-1}) was found in Panikachu with T_{100} treatment and the lowest amount of boron (0.23 mg B kg^{-1}) in Topapana with T_0 (control) treatment. Boron accumulation was gradually increased with the increasing rate of boron levels. Highest boron accumulation was observed in Malancha (22.40 ppm) followed by Barnyard grass (22.39 ppm), Chisra (18.12 ppm), Joina (17.46 ppm), Water cress (16.86 ppm), Panilong (9.75 ppm) and Topapana (7.25 ppm). All weeds showed the highest accumulation of boron at T_{100} treatment (100 mg BL^{-1}). Barrier of boron accumulation by Chisra and Panilong failed at 2 mg BL^{-1} and 12 mg BL^{-1}, respectively and excessive amounts of boron entered into the plant system.

Table 4. Total uptake of boron (μ g pot^{-1})

Treatment	Chisra	Barnyard grass	Malancha	Topapana	Water cress	Panikachu	Joina	Mutha	Panilong
T_0	9.42	76.93	103.46	5.12	218.82	39.57	48.94	ND	28.89
$T_{0.5}$	25.82	93.02	144.96	10.339	272.20	37.29	54.30	ND	17.528
$T_{0.75}$	38.18	92.21	159.93	25.46	190.31	47.74	75.58	ND	29.373
$T_{1.0}$	34.57	77.28	188.67	21.62	343.56	52.42	105.90	ND	28.924
$T_{1.5}$	31.30	76.34	125.29	19.30	331.48	58.94	94.80	ND	25.870
$T_{2.0}$	27.37	77.22	112.875	14.95	347.96	76.56	90.63	ND	25.08
$T_{4.0}$	53.87	57.83	109.51	14.81	333.90	73.97	46.94	ND	24.96
$T_{8.0}$	50.25	66.35	108.37	14.68	348.65	87.33	44.397	ND	24.65
$T_{12.0}$	58.09	74.78	112.97	14.52	398.88	148.62	31.574	ND	18.68
$T_{20.0}$	61.698	57.02	115.20	10.96	221.82	152.54	40.73	ND	24.425
$T_{30.0}$	72.63	33.52	125.36	14.21	209.91	154.15	39.031	ND	4.126
$T_{50.0}$	74.68	13.17	112.34	12.92	128.14	120.51	34.047	ND	2.993
$T_{100.0}$	66.138	11.22	108.64	7.228	41.897	67.64	19.0314	ND	2.662
Level of significance	**	**	**	**	**	**	**	--	**
CV (%)	5.41	10.11	10.27	5.48	6.83	4.21	6.28	ND	5.29

*Source: Pot Experiment 2003-2004. ** Significant at 1% level of probability. In a column figures showing dissimilar letter(s) differ significantly according to DMRT.*

Table 5. Concentration of hot water extractable boron in post harvest soil (ppm B)

Treatment	Chisra	Barnyard grass	Malancha	Topapana	Water cress	Panikachu	Joina	Mutha	Panilong
T_0	3.38e	5.77e-g	4.604b	0.23i	2.31i	4.29e-g	3.30e	1.81e	4.29ef
$T_{0.5}$	0.593g	6.76e	3.30cd	0.65i	4.70h	5.28de	3.50de	1.58e	2.31h
$T_{0.75}$	0.425g	6.24ef	2.67de	2.31f	7.25g	4.98d-f	3.30e	0.83fg	3.60fg
$T_{1.0}$	0.336g	5.27fg	1.52f	1.81g	9.23f	6.26cd	2.31f	0.73g	3.79fg
$T_{1.5}$	0.158f	0.83i	0.553g	1.32h	11.21e	6.26cd	4.29cd	1.60e	5.27d
$T_{2.0}$	5.370c	3.30g	1.320fg	6.26d	13.18b	6.26cd	2.80ef	1.32ef	1.82h
$T_{4.0}$	8.24b	6.26ef	2.02ef	5.27e	7.25g	3.79fg	3.61de	1.62e	6.26e
$T_{8.0}$	2.21e	10.21bc	1.32fg	6.26d	8.73f	4.28e-g	3.30e	1.32ef	5.28d
$T_{12.0}$	2.31e	9.72c	2.51de	5.65e	11.70de	3.30g	3.30e	6.90c	7.25b
$T_{20.0}$	3.00e	4.60g	3.30cd	6.30d	12.39b-d	7.36c	4.89c	6.26d	2.31h
$T_{30.0}$	4.08d	11.2[illegible]	3.90bc	8.89b	12.68bc	8.90b	4.62c	7.89b	4.78de
$T_{50.0}$	5.68c	8.43d	4.68b	7.98c	15.16a	22.07a	7.03b	7.20c	3.30g
$T_{100.0}$	9.73a	15.73a	18.12a	10.62a	12.19cd	23.06a	13.24a	13.12a	10.46a
Level of significance	**	**	**	**	**	**	**	**	**
CV (%)	7.84	7.65	10.24	4.04	4.16	6.80	8.57	5.21	8.40

*Source: Pot Experiment 2003-2004. ** Significant at 1% level of probability. In a column figures showing dissimilar letter(s) differ significantly according to DMRT.*

Conclusion

From the study, it was found that the maximum accumulation of boron occurred in Malancha but for rice field condition, intensity of infestation of malancha is comparatively less. But Chisra, Barnyardgrass and Joina are very much available in the rice field. Among the weeds under test Barnyardgrass was the best performer for boron accumulation. For this reason, for phytoremediation of boron toxicity, Barnyardgrass may be suggested considering its biomass accumulating pattern and toxicity tolerance, while Water cress and Malancha can be used for remediation of stagnant boron contaminated water as a process of phytoremediation technology. Moreover, these boron-accumulated weeds may be disposed in boron deficient soils to upgrade their Boron status.

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Fishermen and Status of Capture Fishery in the River Jamuna : A Case of *Char* Sthal Noahata of Sirajganj District

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Abstract

This paper proffers an account of the status of capture fishery by the fishermen who live in the island char of the river Jamuna. The study was conducted at char Noahata, an island char of Sirajganj district. PRA tools were used for gathering data for the study. Total number of households in the studied village was 246 and out of them 27 were fishermen. The radius of their fishing catchments area is about 3 to 4 kilometers around of the char. Fishermen catch fishes in small groups of 2 to 4 members. They catch fishes by using some traditional gears. Catch composition of fish species varies from month to month. Asar to Agrahaon are the fishing season in this area. Maximum fish are caught when flood water reduces I,e, in the month of Ashwin and Kartik. In this period many poor char dwellers involve themselves in fishing as part time fisherman. Rest six months (from Poush to Jaistha) is dull season for fishing. Only the full time fishermen remain engaged in fishing in this period. In the month of Falgun, the fishermen get lowest amount of fish. They capture every fish whatever they could catch, even they do not think about the size and types of fishes. In the peak season, fishermen can catch about 8-10 kg per day per group and a group can earn on an average taka 350-400/= daily. But this income comes down less than 100-150 taka in the dull season. Fishermen of the char, live their life from hand to mouth. Earnings of a fisherman family are little and uncertain. In the dull season, part time fishermen shift to other professions like agricultural labour, weaving, hawker, rickshaw pulling etc and the full time fishermen work as agricultural labour as well as on fishing. To save the fishing community government may take some initiatives such as releasing fish fry, establishing fish sanctuary etc. To create job opportunity food for works programme may also be undertaken.

Key words: *fishermen, capture fishery, char, Jamuna river, fishing season.*

Introduction

Bangladesh lies at the confluence of three great rivers of the world where the rivers Brahmaputra-Jamuna, the Ganges-Padma, and the Meghna, and their numerous tributaries and distributaries form one of the largest surface water system of the world. The open water inland fisheries of Bangladesh is synonymous with this huge surface water system. During wet monsoon, various

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components of the open water system (river, haor-baors, beels, and floodplain) become interconnected and integrated into a single biological production system providing opportunities for different aquatic animals like fish, prawn, crabs, mussels, etc. to move, breed, feed and grow. This geographical characteristic has made Bangladesh rich in inland capture fishery. In terms of fish production, Bangladesh stands third after China and India as the world's largest inland fish producing country (Farooque 1997). In the past, fish and prawn resources of inland waters were so plentiful that these gave rise to various adages relating fish to the food habit and life style of Bengali people. One such adage is *"machhe-bhate-bangali"* meaning "a Bengali person is made up of fish and rice only" or "fish-rice-bangali".

Large water bodies of the country created opportunities for capture fishery to a lot of poor people. These types of people are catching fish from generation to generation. They lead their life through catching fish from the open water bodies. This type of people are called "fishermen". Generally, the fishermen are landless and poor. They live beside the river or in the *char* of river. The *chars* are areas of new land formed through a continual process of erosion and deposition associated with the major rivers. Fishermen generally live in group, sometimes scattered in the village. Again some people who are not basically fishermen but catch fish seasonally (4-6 months) - are part time fishermen. Part time fishermen catch fish with the full time fishermen group or by forming a small seasonal group. To river side rural people, capture fishery is an easier opportunity for leading their livelihood during the flood. Another adage related to fish is *"likhibo poribo moribo dukkhe, motshya dhoribo, khaibo shukhe"* meaning "I would catch fish and live happily ever after rather than reading writing which will only lead to my drudgery and miserable death". This adage implies that fish was plentiful and catch was easy and comfortable to do, and was much more preferable to hard labour needed for studies.

The days of adages are now a legend of the past. The production volume in inland open water capture fisheries started to decline in both quantity and species diversity. There are various reasons for declining open water capture fisheries production such as over fishing, elimination of aquatic habitats for fish, establishment of flood control dam, irrigation, water pollution and lastly, increase of human population (Tsai, 1997). As a result, fishermen are not getting enough fish and their livelihood status is declining gradually. This study was an attempt to know the present status of capture fisheries by char dwelling fishermen in the Jamuna river. Other objective of the study was to know the status of common fish diversity, fish marketing system and income & expenditure of the char dwelling fishermen's family. The study was conducted in an island char village in the Jamuna river named "Sthal Noahata" of Sirajganj district. Some of PRA tools like Social mapping, Well-being analysis, Seasonality, Time line, FGD, Key informants interview were used for gathering data. Data were collected in 2006.

General information

Island *chars* are completely separated from the mainland by the river for most of the year and are very prone to flooding during the monsoon. Island *chars* have a finite life and are susceptible to changes in the direction of the main river channel. Hence the *chars* have a unique vulnerability to annual flooding and a limited lifespan. *Char* Sthal Noahata is an island *char* located at Sthal Union in Chauhali Upazilla of Sirajgonj district of Bngladesh and occupies an area of 850 acres.

Char Sthal Noahata was attached to mainland before 1955. At that time it was densely populated and emerged as a prominent village especially for its status of education. After 1956, the village along with some other adjacent villages went under the Jamuna river. South part of Noahata was emerged in 1988 and northern part of Noahata was appeared in 1992. At the initial stage, some people settled down in the southern portion as well as started cultivation. In course of time, people from erosion-prone areas moved there and started living but South Noahata is comparatively densely populated.

Topography of *Char* Sthal Noahata is almost homogenous. But the southern part is comparatively higher than the northern. Two canals flow through the north-western part of the char. In the rainy season, most of the area goes under water for 2/3 months and the lowland lies under water for 3-5 months. On the other hand, in dry season water scarcity hampers life of the char dwellers and they also suffer from water for irrigation.

Population and number of households in South Noahata were 1,413 and 246 respectively in January, 2006. Occupations of the dwellers were agriculture, weaving, day labour and fishing. Fishermen of the area are either poor or ultra poor. Boat and net are the main assets of their family. Most of the fishermen have built their house in hired land. Their house consists of one or two rooms made of tin or *chhon* as their ability. The total valuation of most of the fishermen's household assets is below 5000 taka excluding the value of fishing gears and crafts.

Water body

Sthal Noahata is an island *char*. The Jamuna river runs beside every edge of the char. Some seasonal ponds and two large depressions were found in the village. Low land has divided the village into two – south Noahata and north Noahata. During flood, water flows through the low land and divides the village into two parts and hold water for 3 to 5 months. The villagers took an initiative for fish culture in one depression 2/3 years ago, but could not continue for some difficulties, such as, insincerity and lack of trust among the villagers.

Fishermen and fishing area

In all, 27 full time fishermen families live in Noahata. They are involved in fishing round the year. But in fishing season many poor *char* dwellers involve themselves in fishing as part time

fishermen. These poor fishermen are industrious. They catch fish around the Noahata *char*. Their fishing catchment area is about 3 to 4 kilometers in radius of the *char*. Fishermen generally catch fish in a small group (2-4 people). In most cases, members of the same family including 7/8 years' old boy or girl form a group and go for fishing. They need to continue fishing for a long time like 6-7 hours a day.

Fishing gear and crafts

The fishermen catch fish by using some traditional gears like – traps, angling, gill net, small *ber* net, *chhati* net, *sursuri* net, *lengra* net, *current* net etc. The mesh size of the nets is smaller than the recommended size (i.e. < 4.5 c.m). Generally traps are used to catch prawn. As a craft, maximum fishermen use local small boat called "*dingi*".

Available fish species

In the past, abundant fishes were found in the Jamuna river. At that time various species of fishes were available and a large amount was captured by the fishermen. But at present, both the fish species and quantity have declined sharply. Catch composition of fish species varies from month to month. For example, Hilsa is prominent catch of *Ashar* month whereas prawn is in the month of *Jaistha*. However, major fish species are caught in the char in different months as shown in the following table.

Major fish species caught by the fishermen in different months of the year

Bangla Month (with English equivalent)	Major fish caught
Baishakh (14 April to 14 May)	Khorsula (Rhinomugil corsula), Pielli (Labeo ariza), Gulsa (Mystus bleekery), Punti (Puntius spp.), Rui (Labeo rohita), Mrigel (Cirrhinus mrigala) etc
Jaishtha (15 May to 14 June)	Prawn (Macrobrachium rosenbergii), Pielli, Punti, Tengra (Mystus tengra), Batasi (Pseudeutropius atherinoides) etc
Ashar (15 June to 15 July)	Ilish (Hilsa ilisha), khorsula, Pielli, Boal (Wallago attu), Gaora (Clupisoma garua) etc
Shravon (16 July to 15 August)	Prawn, Gaora, Pielli, Bagha ayr (Bagarius bagarius), Rita (Rita rita) etc
Vadra (16 August to 15 September)	Punti, Bhangna (Labeo boga), Raikh (Cirrhinus reba), Tatkini (Cirrhinus reba), Baila (Glossogobius giuris), Ayr (Mystus aor) etc
Ashwin (16 September to 15 October)	Ayr, Gaora, Pabda (Ompok pabda), Gulsa, Chela (Salmostoma bacaila), Prawn etc

Bangla Month (with English equivalent)	Major fish caught
Kartik (16 October to 14 November)	Bhangna, Punti, Chela, Ayr, Gaora, Boal, Shol (Channa striata), Lata (Channa puctata), Baim (Mastacembelus armatus) and so on
Agrahaon (15 November to 14 December)	Pielli, Gulsa, Punti Bhangna, Punti, Chela, Ayr, Gaora, Boal, Shol, Lata, Baim and so on
Poush (15 December to 13 January)	Chapila (Gudusia chapra), Baspatali (Ailia coila), Kaiakata (Gagata sp.), Chela etc
Magh (14 January to 12 February)	Pielli, Gulsa, Punti, Chanda (Parambassis ranga), Chapila etc
Falgun (13 February to 13 March)	Pielli, Gulsa, Punti, Chanda, Chapila etc
Chaitra (14 March to 13 April)	Pielli, Gulsa, Punti, Chanda, Chapila etc

Month-wise availability of fish

Mainly, *Asar* to *Agrahaon* are the fishing season in this area and all the fishermen catch fishes during this period. Maximum fish are caught when flood water reduces. Again, out of the mentioned six months, *Ashwin* and *Kartik* are the peak season of fishing. During this period fishermen can catch around 8-10 kg fish per group per day. However, they get low price of fish these months. On the other hand, rest of the months of the year (from *Poush* to *Jaistha*) is dull season, so only the full time fishermen engage in fishing during this period. In the dull season, on an average, less than two kilograms of fish a day can be caught by a group by netting 6-7 hours. In the month of *Falgun*, the fishermen get lowest amount of fish, $^1/_2 - 1$ kg fish per group per day. In this period the price of fish is comparatively high. Fishermen of this area capture all types of fish whatever they could catch. They do not bother about the size and types of fishes. Month-wise average amount of fishing per day is shown in the following figure.

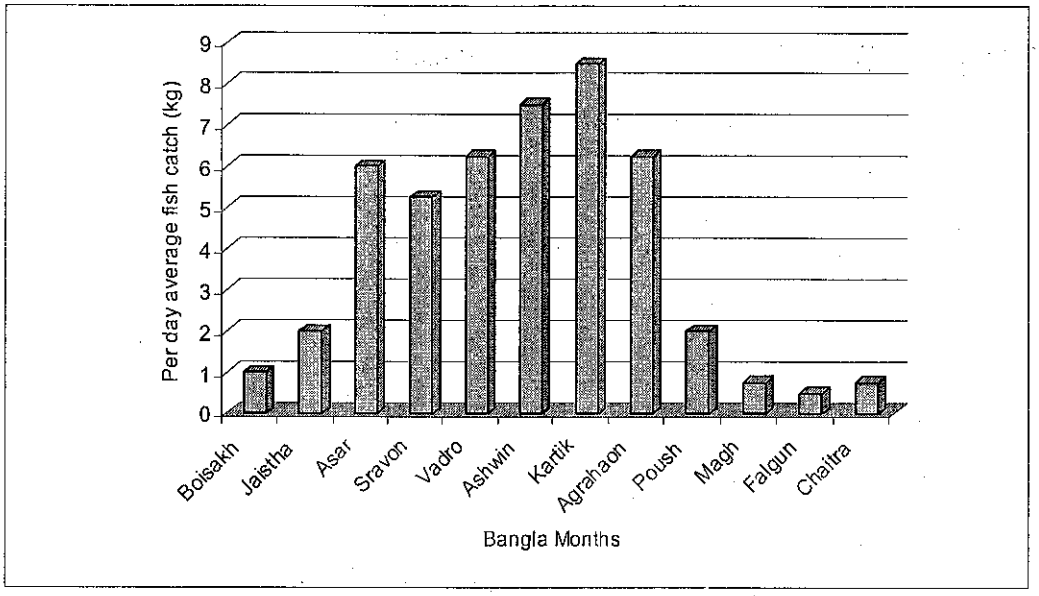

Fig.-1. Month-wise fish catch (kg/group /day)

Fish marketing system

Fish marketing system in the study area are still primitive in nature. Therefore, the fishermen do not get fair price. Three types of fish marketing systems were found in the study area: (a) selling fish in the local market (b) sell through *aratder* and (c) sell to the middleman at the time of fishing.

The fishermen can get good price of fish in the local market at char. In the local market, they sell fish independently as retailer. But, local market does not sit everyday. Besides, the demand of fish in this market is less than the supply. Therefore, they are compelled to sell the fish through *arat* at the nearest fish landing centre, Betil at Belkuchi upazila (though Betil is fish landing centre, there is no modern or scientific facilities there). It is mentionable that most of the fishermen take loan from the *aratder* in advance (mainly for buying nets) with a condition that they will sell their fish through the respective *arat*. So, they are compelled to sell fish through *arat* instead of getting less price. Moreover, they have to pay 5% commission to the *aratder*. Some times, the fishermen sell fish to the middlemen at the time of fishing in the river. In this case they do not get the fair price. Generally, the middlemen purchase the fishes in credit.

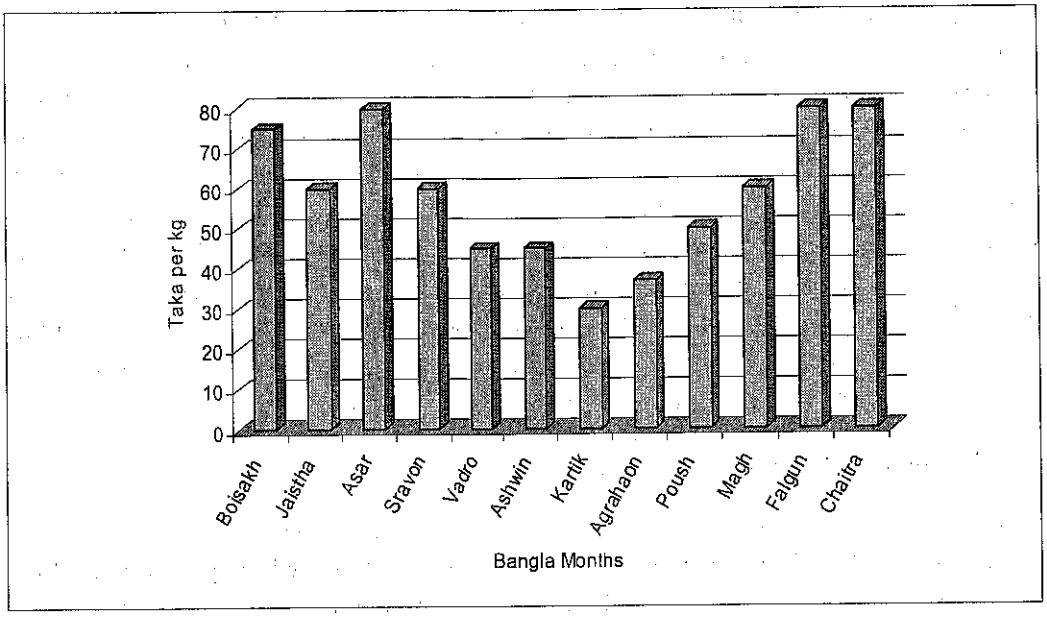

Fig.2: Month-wise fish price in the Betil arat, Belkuchi upazilla town.

Earning and expenditure of fishermen families

Fish price varies from season to season. During the month of *Vadro* to *Agrahaon*, fish is available in the river, but the price of fish is low during this season. In this season, a fishermen group can earn, on an average, 350-400 taka daily. In the month of *Ashar* and *Shravon*, a group can earn the same amount per day thanks to higher fish price in these months, though they can catch fewer amounts of fish. During above six months both fulltime and part time fishermen catch fish. Weather in these months is not always favourable for fishing, so the groups can catch fish 20-22 days in a month. On the other hand, availability of fish decreases in the rest six months and fish price gets higher compared to price at peak catch season. In this period, a group can not earn more than 100-150 taka per day. Only the full time fishermen are engaged in fishing in the lean season. In most of the cases, the groups are formed by the family members only, so that the entire income goes to a family.

Part time fishermen are engaged in weaving, agricultural labour, earth cutting, rickshaw pulling, hawker, and migrate to different towns for selling labour in the lean season. A few members of part time fishermen own 3-4 *bighas* of agricultural land and so they also cultivate their lands.

Fishermen do fishing both in day time and at night. By fishing at night, they get more price of fish, because fish price is higher in the morning than at noon. According to the fishermen, the catch size is decreasing gradually and at present the catch size is about $^{1}/_{10}$ th compared to that of 7/8 years ago.

Earning of a fisherman family is low and uncertain. The poor fishermen usually spend 60-70% of their earning for purchasing food. They generally buy all the foodstuffs round the year. In their menu, vegetables are prominent and animal protein is almost absent. In spite of catching fish, most of them do not eat fish. They can eat enough fish only during the flood season. During this period they can afford lump sum money to meet their other needs. As the fishermen work in water, their wearing clothes (*lungi, genji*) become torned quickly. They are also more susceptible to disease. So they have to spend a good amount of money for buying clothes and medicine. Besides, they need to spend money for buying torch light battery to catch fish during night. They try to meet up all their expenditures besides food with 30-40% of their earning. Sometimes they can not meet their needs with this small amount, so they borrow money with high interest rate which drives them to the vicious cycle of poverty and degrade them to ultra poor.

Conclusion and Recommendations

In the past, various types of fish species were available in the river Jamuna. The availability of fish species has declined sharply and quantity in catch has also decreased. At present Rui, Mrigel, Punti, *Gulsha, tengra, Pielli, Khorsula, Boal,* Prawn, *Bhangra, Chela, Ayr, Bagha ayr, Baspatali, Gaora, Shol, Rita, Baim, Hilsa, Chapila, Chanda* etc are the common fish species in the Jamuna. All of these fishes are not caught in the same season. Catch composition of fish species varies from month to month. *Asar* to *Agrahaon* are the fishing season in this area and all the fishermen catch fishes during this period. Rest six months of the year (from *Poush* to *Jaistha*) is lean season for fishing and only the fulltime fishermen are engaged in fishing in this period. The fishermen can sell their fishes in the local bazaar at the char or through *aratder* or to the middlemen at the time of fishing in the river. Fish price varies from season to season. Price of fish is lowest during the month of *Vadro* to *Agrahaon*, due to abundant availability of fish. In the peak season, a fishermen group of 3-4 members can earn, on an average, Tk. 350-400 per day. In this season a group can not catch fish more than 20-22 days in a month because of unfavourable weather. In the lean season, fish price remains higher compared to price at peak period. But in this season, a group generally can not earn more than Tk.100-150 per day. This amount of income is inadequate to maintain their family. So, they are compelled to do other jobs to meet their daily necessities. To increase fish production in the open water bodies and improve the living conditions of the fishermen the following initiatives should be taken immediately.

- There are two large depressions in the study area. The fishermen can be organized into informal groups and these public water bodies can be leased out to those groups for fish culture. They can also be provided training on fish culture.
- To increase fish production, a certain area of the river can be set as fish sanctuary during the breeding season. To support the fishermen, the government can create alternative job like food-for-work-programme in this period. The fishermen should be informed about laws and regulations of capture fisheries through mass media or by taking special programme in the char areas.

- Through state initiatives fish fries of different species should be released in the river to increase fish production in the open water bodies.
- Easy loan can be provided to the fishing community to purchase net and fishing accessories.
- A good arrangement for fish landing centre and storage facilities can help the fishermen to get fair price.

The above initiatives may be undertaken by the relevant departments and organizations like Department of Fisheries (DoF), District and Upazilla Administration, Local government and Engineering Department (LGED) and Union Parishad. These initiatives can increase fish production in the river, which in turn, can raise income and socioeconomic status of the fishermen community.

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Effectiveness of Micro-Credit Programme of the Concern Worldwide NGO in A Selected Area of Bangladesh

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Abstract

The present study was conducted to examine the effectiveness of the micro-credit programme of the community based organization (CBO) run by Concern Worldwide in a selected area. The study was carried out in the Patgudam, Adarsha and Malancha mohollas of Mymensingh Sadar upazila town area of the Mymensingh district .The respondents were members of the Concern Worldwide NGO. The study is concerned with CBO micro-credit use, repayment performance, identification of the factors affecting repayment performance and the impact of loan on the livelihood improvement of the beneficiaries. It was found that, only an overall 84 percent of the total loan sanctioned was received by the respondents. Maximum amount of loan (89 percent) was received by rickshaw pullers. The loanees used their maximum loan money productively. Ninety six, 94 and 98 percent of the total loan money were utilized purposively by small traders, hair cutting saloon runners and rickshaw pullers, respectively. Repayment performance of CBO micro-credit programme was highly satisfactory. Ninety four percent of the respondents repaid their loan on time with the hope of getting loan in future. Self consciousness and proper supervision by the CBO staffs and Concern Worldwide's field workers were the important contributing factors for timely repayment of loan. Overall, the CBO micro-credit programme was found to have significant positive effect on livelihood improvement of the beneficiaries.

Introduction

Bangladesh is the first country to introduce micro-credit successfully, especially for the poor. At present, more than 1000 NGO micro- financial institutions (MFIs) are operating in the country. These NGOs are one of the most important vehicles providing financial help to low income people, entrepreneurs and producers. Such NGOs are providing an alternative micro-credit model for poverty alleviation that would successfully reduce the problems of low income, low saving, low consumption and other aspects of poverty through their institutional design, credit policy and programmes. *Concern Worldwide* has been working with and on behalf of the poorest and most vulnerable groups in Bangladesh since 1972 on community based micro credit with similar vision and has implemented its micro credit programme on poverty alleviation in Mymensingh district during 1995.

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This study was undertaken to know the effectiveness of the CBO micro-credit programme on the livelihood of the urban poor community people in three selected areas of the sadar upazila town of Mymensingh district- viz. Patgudam, Adarsha and Malancha *mohollas*. The findings of this study are expected to be helpful for the NGOs, government departments and the policy makers in designing relevant socioeconomic development programme for the urban poor, slum dwellers and the poor of the country in general.

Objectives of the Study

The overall objective of the study was to examine the impact of the CBO micro-credit programme on the livelihood of the beneficiaries in the study area. The specific objectives of the study were:

- Document the level of current socioeconomic characteristics of the CBO beneficiaries in the study area;
- Identify the status of the adequacy, utilization and repayment performance of CBO loan by the respondents; and
- Assess the impact of the loan on livelihood improvement of the beneficiaries in the study area.

Methodology

The study was conducted in the Patgudam, Adarsha and Malancha *nohollas** located in the Sadar upazila area of Mymensingh district town. The selected areas were under the CBO micro-credit programme coverage of the *Concern Worldwide* NGO, Mymensingh unit. The loanees were selected by following purposive sampling method. Total size of the sample respondents was 50 for the study. Among the respondents 30 (60%) were small traders, 12 (24%) were saloon workers and 8 (16%) were rickshaw pullers.

Primary data were collected from the sample beneficiaries of the NGO living in the above mentioned *mohollas** during the period from July through August, 2006. Secondary data were collected from the *Concern Worldwide's* project documents. In both cases, structured questionnaire was used.

Results and Discussion

Socioeconomic Characteristics of the Respondents

Socioeconomic characteristics of the respondents may have an important bearing on the receipt of loan from the institutional and non institutional sources. Thus there lies the rationale to examine the socio-economic indicators of respondent households. The indicators examined were: respondent's age, size and composition of the family, level of literacy, occupation, value of assets, annual income, annual expenditure and savings.

*=separate localities of a town where people live/residential places

Age distribution of the respondents

Age distribution of the respondents according to their occupation is presented in Table-1.

Table 1: Age Distribution of the Respondents

Age (years)	IGAs			
	Small trading* (No.)	Saloon (No.)	Rickshaw pulling (No.)	All (No.)
Below 15	-	-	-	-
15-20	2 (6.6)	1 (8.33)	-	3 (6)
21-30	10 (33.33)	6(50)	2(25)	18(36)
31-40	12 (40)	3(25)	3(37.5)	18(36)
41-50	2(6.66)	-	2(25)	4(8)
51-57	1(3.33)	-	1(12.5)	2(4)
Above 57	3 (10.00)	2 (16.67)	-	5 (10)
Total	30 (100)	12 (100)	8 (100)	50 (100)

Source: Field survey, 2006. Figures in parentheses indicate percentage of total. Small trading includes cloth vending, grocery shop, fish and meat selling and vegetables selling.

It was obvious that in the case of small trading and hair cutting saloon, people of the age groups of 31-40 and 21-30 yrs. were more energetic and active than those of other age groups of different occupations. In the case of rickshaw pulling occupation, the age groups 21-30 and 31-40 yrs. included more number of young people.

Family size and composition

The family members of the respondents varied from 2 to 9 in the study area with the overall average of 5.30 which was greater than the national average of 4.89 (BBS, 2004). The average family size of different IGA groups were 5.33, 5.58 and 5.00 respectively for small traders, saloon workers and rickshaw pullers. This indicates that the respondents were not conscious about the importance of smaller family size. The dependency ratio was the highest (4.47) in the case of the saloon workers followed by rickshaw pullers (4.44) and small traders (3.48). Data also show that the average family size of 5.30 persons constituted 2.62 males and 2.72 females making the overall male-female ratio of 1:1.04 which is close to the national male-female ratio of 1:1.05 (BBS, 2004).

Literacy level of the respondents

It is recognized that the problem of illiteracy in Bangladesh is embedded more among the females than the males. The government and various NGOs have been pursuing different programmes for improving literacy rate in the country. To examine the literacy level of the respondents findings were classified into five categories (Table -2). Those who can neither read nor write were considered as illiterate. Those who have no knowledge of reading and writing but can sign only

the name were considered to be in the group 'able to sign only'. Literacy level of an individual was determined in the present study on the basis of years of schooling.

Table- 2: Literacy Level of the Respondents

Literacy Level	Small traders		Saloon workers		Rickshaw pullers		Total	
	No.	%	No.	%	No.	%	No.	%
Illiterate	-	-	-	-	-	-	-	-
Able to sign only	13	43.33	5	41.67	6	75.00	24	48.00
Primary	9	30.00	5	41.67	2	25.00	16	32.00
Secondary	7	23.33	2	16.67	-	-	9	18.00
Above Secondary	1	3.33	-	-	-	-	1	2.00
Total	30	100	12	100	8	100	50	100

Source: Field survey, 2006

Table-2 shows that there was no illiterate member under the CBO micro-credit programme. In the study area, 48 percent of the respondents were able to sign names only and 32 and 18 percent of them had primary and secondary level education, respectively. Only 2 percent of them had education above secondary level. However, only those from small traders, saloon workers and rickshaw pullers who have completed primary education and can sign were more involved in CBO micro credit programme. The respondents in the study area covered by the CBO micro-credit programme were observed to be literate according to the definition so far given by the GoB.

Occupational status of the respondents

It is evident from Table-3 that the main occupations of the respondents were small trading (60 percent), saloon (24 percent) and rickshaw pulling (16 percent). The respondents of hair cutting saloon and rickshaw pulling occupations had no subsidiary livelihood but those of the small traders did have.

Table -3: Occupational Status of the Respondents

Respondent category	Main occupation		Subsidiary occupation	
	No.	%	No.	%
Small trader	30	60	16	32
Saloon worker	12	24	-	-
Rickshaw puller	8	16	-	-
Total	50	100	16	32

Source: Field survey, 2006

Average value of assets of the respondents

Attempt was made to assess the different types of assets which were more or less common for every respondent household. Assets found in the present study were broadly classified into material assets and financial assets (Table-4). The assets in value terms are described in this study. Data show that average value of material assets were estimated at Tk. 17913, 27104 and 11704 for a respondent engaged in small trading, hair cutting saloon and rickshaw pulling respectively. The respective average values of financial assets were estimated at Tk. 2300, 2400 and 1300. Thus the total value of both assets was estimated at Tk. 19223, 29504 and 13004 for the same respondents. It indicates that the total value of all assets expressed in monetary term was found maximum for saloon workers than the other IGA practitioners.

Table -4: Average Value of Assets of the Respondents

Asset types	IGAs		
	Small trader (Tk.)	hair cutting saloon worker (Tk.)	Rickshaw puller(Tk.)
The House itself	10270	14450	7824
Household durables	7643	12654	3880
Total material assets	**17913**	**27104**	**11704**
Cash in hand	450	-	-
Saving in bank	600	400	300
Saving in CBO	1250	2000	1000
Total financial assets	**2300**	**2400**	**1300**
Total in monetary value	**19223**	**29504**	**13004**

Source: Field survey, 2006

Average annual income of respondent households

Annual income in the present study has been calculated by summing up all sorts of income earned from the mentioned IGAs by all the active members including males and females living together and taking meals from the same kitchen. Average annual family income thus calculated were Tk. 41477, 41867 and 38825 for small traders, saloon workers and rickshaw pullers respectively. It may be mentioned that the CBO micro-credit programme has covered people with more or less the same economic strata but many of them had different IGAs.

Table- 5: Average Amount of Annual Income of the Respondent Households

Respondent category	Main (Tk.)	Subsidiary (Tk.)	Total (Tk.)
Small trader	24727	16750	41477
Saloon worker	41867	-	41867
Rickshaw puller	38825	-	38825
All	35139.67	5583.33	40723

Source: Field survey, 2006

Average annual expenditure of the respondent households

Heads of expenditure have been divided mainly into three categories, i.e., business expenditure, capital expenditure and family expenditure and they were summed up to find out total expenditure of the families. To arrive at ultimate average annual savings, annual expenditure of the respondents was taken into consideration which revealed that average annual expenditure levels for small trader, saloon worker and rickshaw puller families were Tk. 39627, 39467 and 37525 respectively (Table -6) .

Table- 6: Average Amount of Annual Expenditure of the Respondent Households

Respondent category	Business expenditure (Tk.)	Capital expenditure (Tk.)	Family expenditure (Tk.)	Total expenditure (Tk.)
Small trader	6143	-	33484	39627
Saloon worker	6608	-	32859	39467
Rickshaw puller	-	7840	29685	37525
All	4250.30	2613.33	32009.30	38873.00

Source: Field survey, 2006

It is evident from Table-6 that the family expenditure, irrespective of respondent category, was much higher than investment in the business. Data also indicate that the total expenditure of different IGA holders was found more or less the same.

Savings of the respondent households

Average saving (difference between income and expenditure) per family came to Tk. 1850, 2587 and 1600 for small trader, saloon worker and rickshaw puller category of the respondents respectively showing more or less positive saving at the end of the year.

Table -7: Savings of the Respondent Households

Respondent category	Annual income (Tk.)	Annual expenditure (Tk.)	Annual saving (Tk.)
Small trader	41477	39627	1850
Saloon worker	42054	39467	2587
Rickshaw puller	39125	37525	1600
All	40885.30	388730.00	2012.33

Source: Field survey, 2006

Adequacy, Utilization and Repayment of CBO Micro-credit by the Respondents

Adequacy of Loan

Capital is required for investing in and drawing output from different IGAs. Credit plays vital role in any sort of trade as it creates scope for further investment. Findings regarding the adequacy of credit required by the borrowers under study have been presented in Table -8.

Table- 8: Level of Adequacy of Received Loan

Respondent category	Average amount applied for (Tk.)	Average amount received (Tk.)	Amount received as % of applied for
Small trader	8000	6400	80.00
Saloon worker	8500	7000	82.35
Rickshaw puller	9000	8000	88.89
All	8500.00	7133.33	83.75

Source: Field survey, 2006

Table- 8 shows that the respondents, in general, received about 80, 82 and 89 percent of the amount applied for small trade, saloon work and rickshaw pulling IGAs, respectively. CBO and *Concern Worldwide* officials held meeting and consulted with the respondents about their loan requirement before sanctioning of loan. CBO micro-credit programme of *Concern Worldwide* followed a single loan policy. It gave one loan at a time and respondents could borrow again after full repayment of the first loan.

Distribution of Loan According to IGAs

Average amount of loan as received by the respondents against specific purpose is shown in Table- 9. The average amount of credit obtained by the rickshaw puller respondents was found maximum (Tk. 8000) while minimum amount was received by small trader respondents (Tk.6400). The average amount of credit received by the respondents for small trade, saloon work and rickshaw pulling in percentage term was 56, 25 and 19, respectively.

Table 9: Distribution of Loan According to IGAs

Respondent category	Number	Total amount received(Tk.)	Average amount received (Tk.)	%
Small trader	30	192000	6400	56.47
Saloon worker	12	84000	7000	24.71
Rickshaw puller	8	64000	8000	18.82
All	50	340000	7133.33	100

Source: Field survey, 2006

Pattern of Loan Utilization

Credit plays a significant role in increasing income and thereby living standard if it is properly utilized. Proper utilization of credit is a prerequisite to attain any aim. Data in the following table show the pattern of utilization of credit money in different purposes.

Table -10: Broad Purpose of Loan Utilization

Respondent category	Business expenditure (Tk.)	Capital expenditure (Tk.)	Family expenditure (Tk.)	Total expenditure (Tk.)
Small trader	6143 (95.98)	-	257 (4.02)	6400 (100)
Saloon worker	6608 (94.40)	-	392 (5.60)	7000 (100)
Rickshaw puller	-	7840 (98.00)	160 (2.00)	8000 (100)

Source: Field survey, 2006. Figures in parenthese indicate percentages of total.

Table -10 shows the percentage distribution of loan spent for different IGAs by the families surveyed. Loan use area has been classified broadly into three categories i.e., capital expenditure, family expenditure and business expenditure which are discussed below.

Capital expenditure

It was found that some of the loanees have invested loan money in capital expenditure such as for purchasing rickshaw. It is evident from the findings that 98 percent of the total loan was invested in capital items by rickshaw pullers. The loan money was not invested to any extent in capital items by any of the small traders and hair cut saloon runners.

Family expenditure

Data show that about 4, 6 and 2 percent of the total loan disbursed was utilized by small traders, saloon workers and rickshaw pullers, respectively for meeting various items of daily family needs (Table -10). The family expenditure constituted purchase of food and clothes, medicare and payment of loan installment. From the presented findings, it is apparent that a negligible proportion of loan was found to have been used in family expenditure showing a good sign of proper loan use by the respondents in the study area.

Business expenditure

Business expenditure was the main cost head for small traders and hair cut saloon runners respondents. They were reported to have incurred about 96 and 94 percent of the total loan money for investment in business (Table -10). This indicates that most of the loan money was utilized in business activities by small traders and saloon holders.

Loan Repayment

Repayment of credit is mostly related to its effective utilization. Use of credit for unproductive purposes creates overdue of loans and weakens the financial institutions. Repayment status is one of the crucial aspects of credit analysis. Proper utilization of credit has a great influence upon the repayment capacity of the borrowers.

The mode of loan repayment of CBO micro-credit programme was on weekly basis and the total amount of loan along with interest was to be repaid in 40 equal installments starting from the next week of receiving the loan in hand. Eight weeks were introduced to avoid holidays and grace period of loan. Interest rate was 12% per annum.

Table- 11: Repayment of Loan According to IGAs

Respondent category	Average amount repaid				% of total repayment
	Installment (No.)	Principal (Tk.)	Interest (Tk.)	Total (Tk.)	
Small trader	40	6400	768	7168	100
Saloon worker	40	7000	840	7840	100
Rickshaw puller	40	8000	960	8960	100
All	40	7133.33	856.00	7989.33	100.00

Source: Field survey, 2006

The average amount of loan due for repayment was found to be Tk. 7168, 7840 and 8960 for small trader, saloon worker and rickshaw puller respondents respectively and 100 percent of the loan was repaid by all the categories in course of 40 installments. So, the overall loan money repayment status observed during the study period was fully satisfactory.

Factors Affecting Timely Loan Repayment

The respondents were asked to express the reasons which inspired them to repay the loan installments timely and regularly. Tabular analysis has been done to identify the relative contribution of various factors towards loan repayment performance which is shown in Table -12.

Table- 12: Factors Affecting Timely Loan Repayment

Factors	Number and percentages of members*	
	No.	%
To get further loan	47	94
Self consciousness	45	90
Proper supervision by CBO staffs and Concern Worldwide field workers	41	82
Pressure of group leaders and other group members	12	24
Easy to pay by installment	39	78
Having more income by using loan	26	52

**Summation of percentages will not to be equal to 100 because of multiple answers given by the same respondent.*

In this connection six relevant questions were put to the respondents. Out of 50 beneficiaries, 94 percent reported that they repaid their loan in time with the hope of getting more loan in future. Almost 90, 82, 78, 52 and 24 percent of the respondents were recorded to have repaid their loan money on time because of self consciousness, proper supervision by CBO staff and *Concern Worldwide* field workers, easy to pay by installment, having more income by using loan money and pressure of group leaders and other group members of the IGA activities.

Impact of CBO Micro-Credit Programme on Livelihoods of the Respondents

Households

Changes, due to contributing factors, in livelihood pattern of the loanee's are shown here as accumulation of capital, food intake, clothing, health, sanitation and decision making freedom of women.

Livelihood

A livelihood is the set of capabilities, assets and activities that furnish the means for people to meet their basic needs and support their well being. Building livelihoods is not simply a localized phenomenon but connected with environmental, economic, political and cultural processes to wider national, regional and global arenas. In this guideline, "livelihood" does not just mean the activities that people carry out to earn a living. Rather, it means all the different elements that contribute to or affect their ability to ensure a living for themselves and their households.

Changes in Overall Livelihood pattern of the Respondents

In order to identify the overall socioeconomic improvement in the livelihood, the respondents were asked to give their opinion on their overall socioeconomic changes obtained by using CBO micro-credit. Table- 13 presents the results. Which show that in 92 percent cases CBO micro-credit changed their awareness after taking loan. Other livelihood indicators (family income,

furniture, education, assets, household savings, food intake and clothing) also improved. On the other hand, there has occurred a modest improvement in health facilities, housing conditions, sanitations and use of tubewell water of the loanees.

Table- 13: Changes in Socio-economic Condition of the Respondents

Heads	Changed (%)	Not changed (%)	Total (%)
Awareness	92	8	100
Family income	84	16	100
Furniture	80	20	100
Education	76	24	100
Assets	66	34	100
Household saving	60	32	100
Food intake	60	40	100
Clothing	50	50	100
Health facilities	44	56	100
Housing condition	26	74	100
Sanitation	24	76	100
Using tubewell water	12	88	100

Participation of Women in Household Decision Making

Traditionally, women in our social system do not have any or have little say in making decisions on any sort of household affairs particularly in poor households. They have little expectation from whatever scope there may be to allow them to participate in decision making that could change their livelihood and living. The CBO micro-credit programme was expected to make a breakthrough in this very aspect. Table -14 depicts whether any change in decision making status of women occurred because of their involvement in the CBO micro-credit programme.

It was found that the male dominated role in household affairs has been reduced to a greater extent after joining of women in CBO micro-credit programme. The male members who previously took monopoly decision in household affairs could realize that females should also join in decision making process. The worth mentioning result in this respect is evident in the case of purchasing rickshaw (100 percent), followed by daughter's marriage (62 percent), housing (56 percent), business (54 percent), children education (50 percent) and taking care of children (40 percent). It can, therefore, be said that the CBO loan operation had been helping the potential women empowerment in the society wherein the GoB at present has given priority as part of global importance of the matter. Equal participation of male and female in household decision making has already been globally recognized for peaceful family life and the findings of the present study may at least be a new addition to the existing knowledge in this respect.

Table- 14: Participation of Women in Household Decision Making

Heads of participation	Before joining the CBO micro-credit programme (%)			After joining the CBO micro-credit programme (%)		
	Men only	Women only	Men in consultation with women	Men only	Women only	Men in consultation with women
Business	55	32	13	14	32	54
Purchasing rickshaw	-	-	-	-	-	100
Housing	68	10	22	34	10	56
Taking care of children	10	75	25	5	65	40
Children education	30	40	30	15	35	50
Daughter's marriage	64	6	30	32	6	62

Summation of percentages will not be equal to 100 because of multiple answers given by the same respondent.

Conclusion

Based on the findings of the study, the following conclusions can be drawn:

- CBO micro-credit programme could positively contribute to reducing poverty in the study area as shown through certain socioeconomic indicators ;
- The loan repayment performance of the CBO micro-credit respondents was highly satisfactory;
- The CBO micro-credit programme has positively changed some of the socioeconomic variables of the beneficiaries and has empowered women members in family decision making process.

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Arsenic Contamination Status in the Selected Chars in the Middle of the Large Jamuna-Brahmaputra River System

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Abstract

This study was conducted in three Chars (sandbars) in the middle of the large Jamuna-Brahmaputra river system under the districts of Gibandha and Kurigram for assessing the concentration level of Arsenic (As) in the STW water. Tests of 30 samples were carried out successfully by using field kit and 20% of the tested samples were further tested in DPHE laboratory by analytical method.

The concentration levels of As have been found at 10 to 200 ppb in char Kalasona. It was discovered that the shallow aquifer was contaminated up to 18.29 m. Beyond this limit the aquifer was safe from As. In Char Kismat sadar, the people were extracting fully contaminated water from shallow aquifer (10.67m.) though STWs in most cases except for a few from the safe deep aquifer (>10.67m depth).

The contamination level of As in ground water in Juan Satra char was 25 to 125 ppb. The only STW belonging to one char dweller, Abtar, As level was found to have As-concentration (25ppb) within the limit of Bangladesh national standard. In Char Corpora As level of core STW was 75ppb but STWs at the Southern part were beyond the acceptable limit. On the other hand safe water was found at the Northern side of the Char. It is to be emphasized that the groundwater quality should be investigated by performing test boring in Kismatsadar, Joansatra and Korpora chars for supplying safe water to their inhabitants. Water quality in char Bhogobotipur was quite good as the As level in that area was found zero to 35 ppb which lies within the acceptable limit. There is an argent need to abandon this harmful practice. This can be done by switching over to the extraction of water.

Background

Bangladesh's water crisis affects both rural and urban areas. Water quality is also a matter of great concern where water is abundant during monsoon. Bangladesh is a highly populous country. Groundwater, so far, is the main water source for drinking and domestic purposes and is extracted through tube wells introduced by both private and public sectors. A recent study reports that in 59 districts out of 64, ground water was contaminated by As. The high level of As was detected first in 1993 in Chapai Nawabgonj district of Bangladesh (Khan et. al. 1997). Another study reported

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that the groundwaters (GW) of the south-western areas of the country, excluding the Deep tube wells aquifer of the costal belt are contaminated by As (Chowdhuri 2004).
Shallow groundwater with high As concentrations from naturally occurring sources is the primary source of drinking water for millions of people in Bangladesh. It has resulted in a major public health crisis with as many as 70 million people possibly at risk (IAEA).

As is a cumulative substance, which slowly passes out of the body through the urine, hair, fingernails/toe nails, and skin. It takes around 8-14 years after starting to drink arsenic contaminated water for symptoms to appear. This period depends on the amount of As ingested, the length of exposure and immunity level of the person. Symptoms at the initial stage of the disease are skin pigmentation, eye infections, trachea and cancer. Although arsenicosis, the disease caused by arsenic contamination, is not infectious, contagious or hereditary, it creates social problems for the victims and their families.

The occurrence of arsenic diseases depends on the ingestion of arsenic compounds and their excretion from the body. It has been reported that 40% to 60% arsenic can be retained by the human body (Farmer & Johnson1990). So immediate steps should be taken to aware char people, not to take arsenic contaminated water for drinking purpose

Drinking water quality standard regarding Arsenic		
Parameter	**WHO standard (1993) (ppb)**	**Bangladesh standard (1997) (ppb)**
Arsenic	*10*	*50*

The Chars Livelihoods Program (CLP) is UK-government funded development work being implemented in the char areas of the north-west Bangladesh. It works with ultra poor living on the chars (sand bars) in the middle of the large Jamuna-Brahmaputra river system. These chars are frequently formed and eroded by the river during seasonal monsoon floods, leaving their residents extremely vulnerable to displacement. One of the key aspect of the project is to build flat-topped sand platforms or plinths for people to live on top of although these plinths do not prevent major erosion of the islands on which they are situated, in a mild but high flood they do ensure a dry livable dwelling, and also a refuge for those not fortunate enough to live above the flood line.

CLP has built more than 58,000 plinths over the last years. On the raised plinths the project also plans to ensure safe water supply round the year to 100,000 households (BHHs) on relocated raised plinths. Water supply is planned through using ground water by installing shallow tube wells (STWs) in its programme area. These STWs have been installed by CLP's contracted NGOs although the quality of water from these STWs has not always been verified by testing.

Considering the importance of the problem, on request of the CLP, this study was conducted by the Centre for Irrigation and Water management (CIWM), RDA, Bogra.

Objectives

The main objective of this study was to measure the concentration of As present in the hand tube-wells as recorded by CLP in different chars. The specific objectives of the study were to:

i) Assess the arsenic concentration in drinking water at the field level using field kit and through the laboratory test using analytical method; and

ii) Compare the results obtained through both analytical and field kit methods with recommended standard and identify As free areas for drilling DTWs for water supply to the char people.

Methodology

The study was undertaken at six locations of five chars- namely Char Kalasona (one location) of Fulchari upazila Char Kismatsadar (two location) of Sundargonj upazilla under Gibandha district and one site each in Joansatra, Korpora & Bhobotipur chars of Kurigram district. The STWs installed/selected by CLP were treated as core STWs. Water samples have been collected from surrounding four STWs within the periphery of six core STWs identified by the CLP. The number of core STWs are fixed (i.e. 6) but the number of peripheral STWs varied according to the real situation and availability. The sample for As-test included one core STW and four surrounding STWs at each location. Six water samples were collected from each site following the rules and regulation of water testing laboratory under air tight condition. Thus the total collected sample size was 30 for testing As using Field kits of which 20% samples were revalidated by analytical test in the DPHE laboratory. The test results were compared with reference level (WHO and Bangladesh drinking water standard). A 4-member team of CIWM, RDA, Bogra was assigned to conduct the study. The team visited the char areas physically and performed the tests in August of 2008. In the study the levels of As presents in pre- selected STWs and the individual surrounding STWs were tested.

Results and Discussion

The concentration levels of As present in STWs water tested in field level and DPHE laboratory are tabulated in detailed are appended in Table-1.

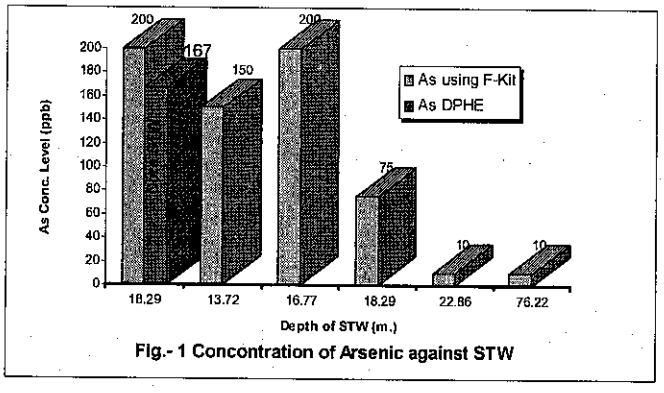

Fig.- 1 Concentration of Arsenic against STW

Char Kalasona is located in the middle of the large Jamuna river. A lot of activities have been undertaken in this char by an NGO named Gono Unnayan Kendro (GUK) through CLP. The core STW which belongs to Saifuddin- a char inhabitant is located at the heart of the village. Neighbors also draw from this facility. The boring depth of this STW was about 18.3 m. The concentration of As present in the water of this STW was found about 200 ppb, while confirmation done at DPHE laboratory showed the concentration level at 167 ppb. The concentration levels of As in individual STWs at different boring depths are graphically shown in Figure- 1 that shows of the concentration levels of As in these STWs are less and lies within the limit of Bangladesh Standard beyond the depth of 18.3 m.

Kismatsadar is an island char and is located beside the river Paglatista in Belka Union under the Upazila Sundargonj of Gibandha District. Two of the core STWs are located in this char village. Most of the households in this char have their own hand tube-wells which draw water from very shallow aquifer not exceeding 12.2 m. The first core STW belongs to Md. Abdus Samad. The As concentration level in the water of this STW was found about 100 ppb that exceeds the drinking water standard of WHO as well as that of Bangladesh. The result obtained from DPHE laboratory was 55 ppb. The As concentrations of the surrounding STWs and the core STW at different depths are in presented Figure-2.

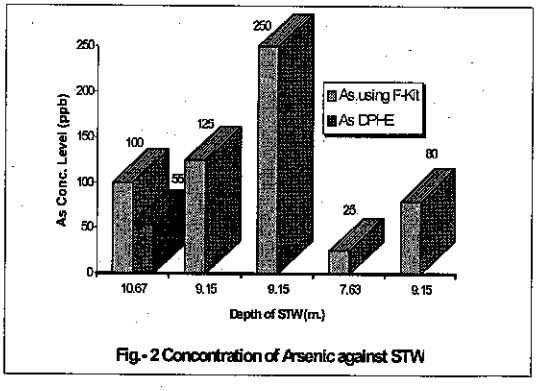

Fig.- 2 Concentration of Arsenic against STW

Table-1: Concentrations of Arsenic Present in STW Water under Study

Sl. No.	District	Gibandha															
1	Upazila	Fulchari						Sundargonj									
2	Union	Uria						Belka									
3	Village	Char Kalasona						Kismat Sadar									
4	Core HT Woner	Saif Uddin						Md Alam					Abdus Samad				
5	HT Woner Tested for As	Saif Uddin	Hossain Ali	Noor Mohammad	Chan Meah	sabed Ali	Public (Tara Pump)	Md. Alam	Sahad	Hakim Uddin	Andadul	Montu	Abdus Samad	Sofiz	Amin	Momtaj	Sobiul
6	Sample Code	$S_{(GFUK-1)}$	$S_{(GFUK-2)}$	$S_{(GFUK-3)}$	$S_{(GFUK-4)}$	$S_{(GFUK-5)}$	$S_{(GFUK-6)}$	$S_{(GSBK-1)}$	$S_{(GSBK-2)}$	$S_{(GSBK-3)}$	$S_{(GSBK-4)}$	$S_{(GSBK-5)}$	$S_{(GSBK-1)}$	$S_{(GSBK-2)}$	$S_{(GSBK-3)}$	$S_{(GSBK-4)}$	$S_{(GSBK-5)}$
7	Distance from Core STW (m)	0	27.44	29.27	48.78	51.83	-	0	11.58	60.97	67.07	76.22	0	38.11	45.73	60.97	122
8	Depth of STWs (m)	18.29	13.72	16.77	18.29	22.86	76.22	10.67	9.15	9.15	9.15	9.15	10.67	9.15	9.15	7.63	9.15
9	Arsenic (As) in ppb by Field Kits	200	150	200	75	10	10	210	100	150	25	75	100	125	250	25	80
10	Arsenic (As) in ppb by Analytical Meth.	167						179					55				

Sl. No.	District	Kurigram														
1	Upazila	Ulipur										Kurigram Sadar				
2	Union	Thatrai					Doldolia					Jatrapur				
3	Village	Joan Satra					Char Korpora					Char Bhogobotipur				
4	Core HT Woner	Abdur Rahman					Montu					Abdus Sattar				
5	HT Woner Tested for As	Abdur Rahman	Abtar	Mohubor	Mezbanu	Minara	Montu	Dulala	Motiar	Mojibor	Bosunia	Jamal Uddin	Abdus Sattar	Hobibor Rahman	Abul Hossain	Eusuf
6	Sample Code	$S_{(KUTJ-1)}$	$S_{(KUTJ-2)}$	$S_{(KUTJ-3)}$	$S_{(KUTJ-4)}$	$S_{(KUTJ-5)}$	$S_{(KUDK-1)}$	$S_{(KUDK-2)}$	$S_{(KUDK-3)}$	$S_{(KUDK-4)}$	$S_{(KUDK-5)}$	$S_{(KKJB-1)}$	$S_{(KKJB-2)}$	$S_{(KKJB-3)}$	$S_{(KKJB-4)}$	
7	Distance from Core STW (m)	0	30.49	51.22	81.71	198.2	0	15.24	25.91	28.96	30.49	0	9.15	15.24	19.52	9.15
8	Depth of STWs (m)	13.72	10.67	10.67		25.91	18.9	11.58	7.62	7.62	10.67	12.2	10.67	12.2	-	10.67
9	Arsenic (As) in ppb by Field Kits	75	25	125	75	100	75	80	35	25	80	25	10	35	10	Nill
10	Arsenic (As) in ppb by Analytical Meth.	44				56	56					20				

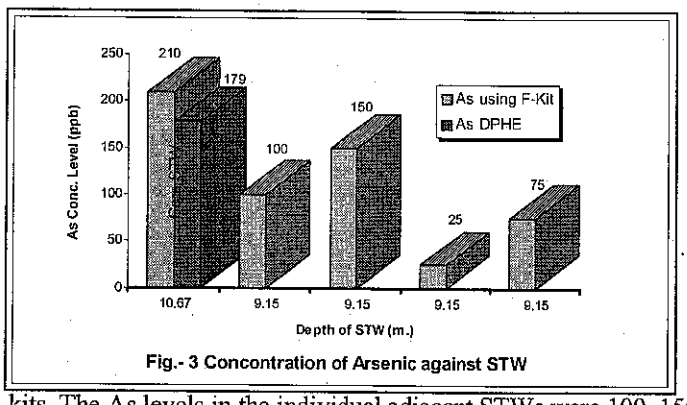

Fig.- 3 Concontration of Arsenic against STW

Md. Alam is the owner of the second core STW. The concentration of As in this STW tested by Field kits was found 210 ppb which was beyond the permissible limit for drinking water. The As level of this core STW measured in the DPHE lab was 179 ppb, which was closed to the result obtained through Field kits. The As levels in the individual adjacent STWs were 100, 150, 25 and 75 ppb, respectively (Fig.-3). All these values except from the STW of another char villager Andadul (25 ppb) lies beyond the limit suggested by WHO and Bangladesh standard. The locations of these STWs as per their liner distance are schematically given in Figure-3. Results suggest that peoples in this char lands are in alarming situation and can be suggested that , drinking water for them should be extracted from deep aquifer to overcome the crisis.

The Char JoanSatra is isolated by the river Tista from main land of Ulipur Union under the District Kurigram. CLP extended also a lot of development activities in this char through the NGO Mahideb Jubo Somaj Kallayan Somity (MJSKS). The core with the platform facility STW in this site belongs to Abdur Rahman. The boring depth of this STW is about 13.72 m. The concentration of As present in the STW water was about 75 ppb which exceeds the permissible limit. The result of DPHE laboratory also showed the As concentration level (44ppb) of that core STW was beyond the limit of WHO and Bangladesh standard. The concentration of As in individual STWs at different boring depths are illustrated in Figure- 4. The figure illustrates that the concentration of As at 10.67 m depth in STW number #2 (25 ppb) lies within the Bangladesh drinking water standard.

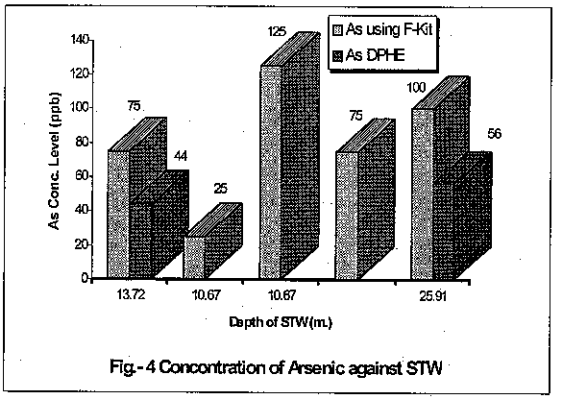

Fig.- 4 Concontration of Arsenic against STW

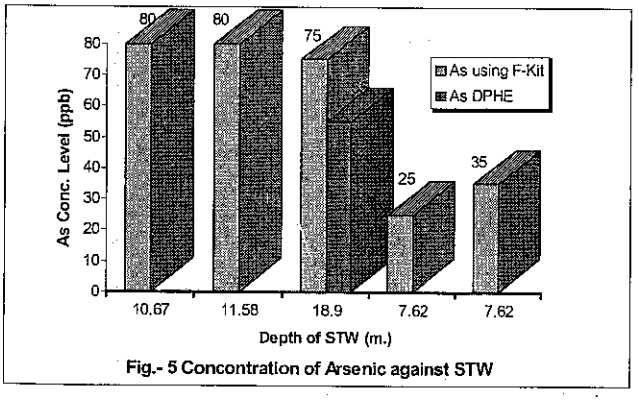

Fig.- 5 Concontration of Arsenic against STW

Char Korpora is located besides the river Tista in Doldolia Union under the Upazila Ulipur of Kurigram District. It is an isolated Char where in most of the households have their own STWs. The core STW installed by CLP is owner possessed by the inhabitant Montu. This STW can draw water from the aquifer of 18.9 m depth. Concentration of As in its water as tested through Field kits was found 75 ppb while the test results of DPHE showed the concentration to be 25 ppb. The concentrations of As in STWs of the northern part of the core STW area were found within the standard levels and for those of the southern part- beyond the standard levels. As levels in the water of the STWs located at Northern and Southern parts are graphically shown in Figure-5 against their boring depths.

Char Bhogobotipur is under Kurigram sadar but totally isolated from mainland of Jatrapur Union. It is the longest Char of the river Brohmaputra. Most of the households hence have their own STWs which extract water from a shallow aquifer of not more than 12.2 m. The core STW in this char has a depth 12.2m and it is under the custody of Jalal Uddin. Arsenic level in this STW is 25 ppb which is good and lies within the limit of Bangladesh standard.

The result obtained from DPHE laboratory showed its As-level at 20 ppb which is close to the result obtained through Field kits test. The As concentrations at different aquifer depths of the surrounding STWs as well as of the core STW are graphically shown in Fig-6.

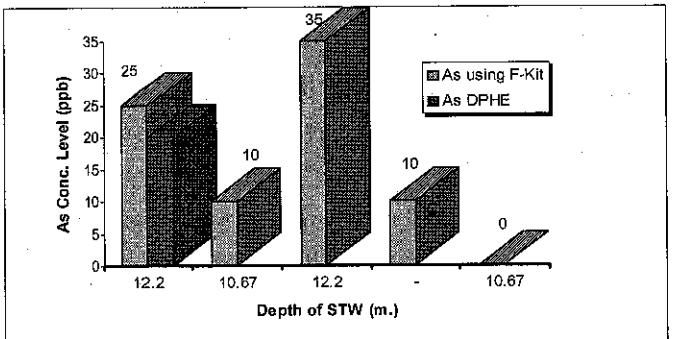

Fig.- 6 Concontration of Arsenic against STW

Conclusion

In Char Kalasona shallow aquifer was contaminated up to 18.29 m. Beyond this limit the aquifer was safe (10ppb). High levels of As were detected in Kismatsadar, Kalasona, and Joansatra chars (250, 210 and 125 ppb).

The aquifer qualities at shallow depth (12.2m) were totally contaminated by As in the char areas except Char Bhogobotipur where the maximum As level was 35 ppb which is within the limit of drinking water standards of Bangladesh. In char kismatsadar, Joansatra, Korpora the ranges of As in groundwater were 25-250, 25-125 and 25-80 ppb, respectively.

Arsenic concentration level tested by analytical method usually less than that of result performed by Field kits method, no deviations were found in this study also.

Example:

- Greenland, D.J. (1997) The Sustainability of Rice Farming, New York: CAB International *in association with* International Rice Research Institute (IRRI) (in case of book/monograph article reference).
- Jabbar, M.A. and Orr, A.W. (2005) Interaction Between Weed and Water Management in Boro Rice: A Case of Comilla District in Bangladesh. *The Bangladesh Rural Development Studies,* XI: 35-53 (in case of journal article reference).
- Savithri, P., Perumal, R, and Nagarajan, R. (1999) Soil and Crop Management Technologies for Enhancing Rice Production under Micronutrient Constraints. *In*: V.Balasubramanian, J. K. Ladha and G. L. Denning (Eds.) *Resource Management in Rice Systems: Nurtients.* Kluwer Academic Publishers, London, UK, pp.121-135 (in case of compendium/ proceedings/report article reference).

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