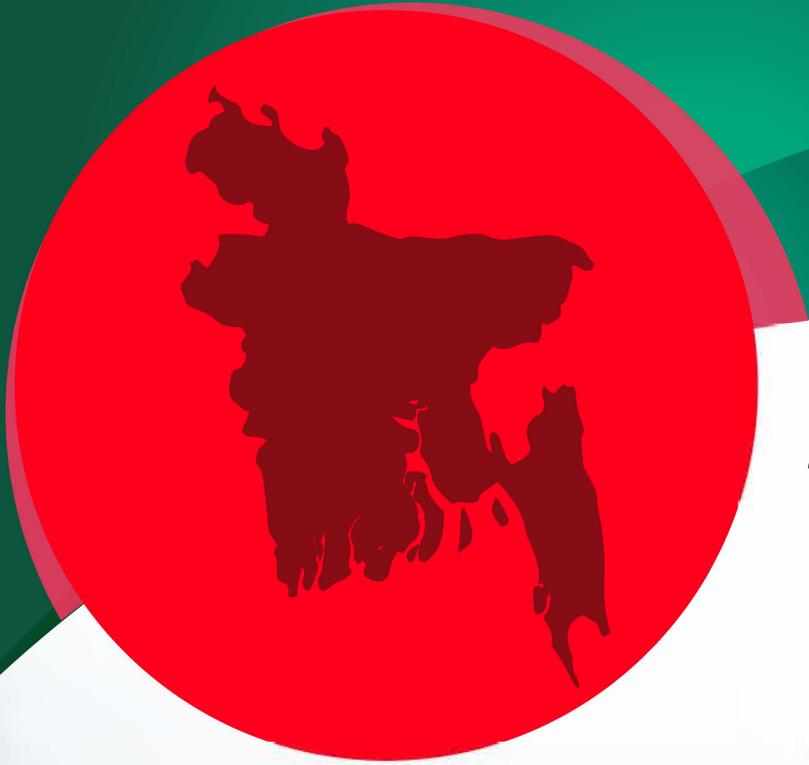


Volume 8
Number 2
Year 2006
ISSN 1529-0905



Journal of
**BANGLADESH
STUDIES**



TABLE OF CONTENTS

From the Editor	Syed S. Andaleeb	iv
 <i>ARTICLES</i>		
Science and Technology Development in Bangladesh: Failure in Policy Implementation	Iqbal Mahmud	1
Commentary	Munir Quddus	14
Commentary	Nazrul Islam	18
Commentary	Ashraf Ali	21
Commentary	Shafiqur M. Rahman	24
Women's Political Participation in Bangladesh and India: Symbolic or Real?	Pranab Kumar Panday	26
Arsenic Mitigation Technologies in Bangladesh: Evidence from the Literature	N. Nahar T. Honda	45
Problems and Prospects of Shrimp and Rice-Prawn Gher Farming System in Bangladesh	Basanta Kumar Barmon Kondo Takumi Fumio Osanami	61

FROM THE EDITOR

At the time of writing this editorial, when Bangladesh is at another crossroads, the words of Charles Dickens seem to be most apt: It was the best of times, it was the worst of times...it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us

In the early weeks since January 12th, 2007, as the alleged criminal elements associated with state power were being incarcerated, one after another, for their reprehensible acts of corruption, the country was at a euphoric high. In more recent weeks, that euphoria seems to have been stymied at the stalling pace of progress and the seeming hesitation of the Caretaker Government (CTG) in staying the course. A sense of uncertainty has also begun to cast its pall on the country. First there was much talk about the exile of the leaders of the two most powerful political parties, then there was a reversal of the decision, all introducing many questions about who is running the show, to what purpose, and what awaits the nation, especially the fate of democracy. Concern for democracy stems from the fact that one researcher found that there were 52 cases of democratic regimes that were replaced by non-democratic ones while another noted 47 such reversals from 1900-1985.

Moreover while the nation still continues to breathe a sigh of relief from the oppressive environment created by the past regime, public services have improved only marginally, if at all; prices continue to remain at lofty heights; and the perceived sense of security has begun to decline. Also, with the suspension of many rights of the ordinary citizen, purportedly in the name of bringing about stability, some anxiety has begun to set in. Lower-tier businessmen have become fearful of being the next target. Their fear emanates largely from the fact that corruption has dispersed and trickled deep into various tiers of society, by choice or otherwise, and now there is concern about who is next.

Under the circumstances, the time is ripe for debate about many emerging issues: the role of the CTG and if it is needed at all; what fosters regimes of unbridled corruption that Bangladesh has endured and what changes are needed to curb such proclivities; how should the country go about choosing its leaders and how many terms should a particular leader be allowed to reign; and so on. The opportunity for the social scientist today is rich with the promise of finding enduring solutions to the country's problems. JBS awaits the considered views

of scholars on the above questions and related ones that remain unanswered or only partially so to help find the path of emancipation. With their keen analysis and insights, adapted theoretical frameworks, and bold visionary ideas, JBS aspires to imbue others as well to address the vital questions of the hour.

In this issue we present four insightful essays that are varied in their focus, but deeply relevant for policy makers and social scientists in the country. Iqbal Mahmud ponders the vital question of why science and technology education has eluded the country and reflects on its adverse implications. According to him, an underdeveloped appreciation of technology culture and the spirit of inquiry, absence of a needed socio-economic setting for these to flourish, lack of R&D, externally driven/imposed technology, and an education system that stifles inquisitive minds are at the root of a languishing technology-driven economy that portends serious competitive challenges and economic backwardness for the country in an era of globalization. It is true that technology and innovation, along with a solid education system, represent the backbone of a nation's competitiveness and ability to grow rapidly with equitable distribution. Unless these elements are harnessed for and by the nation's workforce, Bangladesh will not see the dizzying pace of growth that other South East Asian or some South Asian nations have witnessed in recent times. It is absolutely vital that the technology issue should move closer to center stage in the policy hierarchy if the nation's leaders and policy makers desire true economic emancipation. To elaborate on the role, benefits and challenges of technology, four commentaries are also offered for further deliberation on strengthening technology policy of the country.

Pranab Kumar Pandey focuses on a structural dimension of society--the role and position of women--that is sad, dehumanizing, and subject to exploitation: incomprehensible at this day and age. Consequently, a growing number of scholars have been examining the gender divide in the country and the region. Often relegated to the margins of society because of socio-economic forces, traditions, lack of a legal structure to serve and protect them, a patriarchal orientation that demands favored treatment for males, and political forces that have continued to ignore them despite two political leaders being women in recent times, the plight of women remains firmly rooted to its past. This article examines the present state of women's political participation in two neighboring countries:

Bangladesh and India. The challenges of better integrating them in society, are indeed daunting as the article shows, reflecting the durability of certain social structures that may have outlived their value.

In fact, women are partaking in greater numbers in organizational life today. From service establishments to manufacturing organizations, from government bodies to multinationals, and from NGOs to voluntary organizations, all have seen a steady increase in the number of employed women. With their increasing presence, there is brewing a large and contentious issue of integrating them in organizations designed by men. As participants and contributors, their role and involvement in organizational affairs will become more significant over time. Unless this emerging demographic phenomenon is given unequivocal attention now, organizations of the future may have to confront many new challenges that will cut deeply into their overall performance. The author's call for a paradigm shift is indeed appealing that bestows greater freedom to the women and empowers them to leave their own indelible impression on societies that have wrongfully relegated them to obscurity, injustice, and lacking in worth when their true contributions to societal harmony and progress are far greater than what many of these male dominated societies make it to be.

N. Nahar and T. Honda focus on a problem of enormous proportions—the arsenic conundrum—that has crept almost unnoticed into the nation's very existence. Portending unimaginable health consequences, quite beyond the ability of the nation to deal with in a comprehensive manner, an estimated 50 million people in Bangladesh are confronted today with arsenic contaminated drinking water. In some parts of the country, more than 80% of the tube wells that furnish the kitchens and pitchers are contaminated, spreading arsenicosis among the population. With no immediate viable alternatives in sight a massive environmental health catastrophe is waiting in the wings to be unleashed on the nation. What needs to be done? The authors make a serious effort to identify solutions along with the costs of adopting various alternatives. Unless a concerted effort is launched immediately with national and international involvement, the price to be paid down the line seems incalculable in financial, political, social and environmental terms. The question is whether the leaders and policy makers, firmly ensconced in the country's capital, and bickering over mundane things, comprehend the magnitude of the problem and the massive destabilization that is likely to ensue with major migrations to and from different parts of the country with social, political, economic, demographic, and health consequences?

Finally, Basanta Kumar Barmon, Kondo Takumi, and Fumio Osanami address a variety of issues surrounding shrimp farming that represents the second largest export industry in the country and contributes 4.7% of GDP and 9.38% of total exports. Shrimp farming affects the environment, ecology, land degradation rates, livestock production, and water quality in ways that must be better understood. By examining its symbiotic relationship with paddy production, the authors propose improving rice-prawn gher farming systems that are economically viable and sustainable, while making substantive contributions to employment opportunities and export growth of the country. Greater attention of researchers and policy makers to this vital industry can boost economic development based on comparative advantages, engage more people in finding gainful employment, and help diversify the country's export base, while enabling supporting industries such as storage, packaging, transportation, etc., to grow as well.

As always, bringing out each issue of the journal relies on the unremunerated assistance of various individuals with a diverse array of skills to whom we owe our deepest gratitude. These include our reviewers, editors, and staff assistants. To help with this issue, we received help from two new editors, Sartaz Aziz and Shahnaz Y. Andaleeb, who edited the manuscripts scrupulously and with great diligence and patience. The untiring efforts of Sue Pennington who puts everything together at the end are also commendable. To all these contributors, I offer my sincere thanks.

Finally I would like to take this opportunity to welcome Bangladesh Enterprise Institute (B.E.I.) and Services for Professional Education and Enterprise Development (S.P.E.E.D), our strategic partners in Bangladesh, who will work with us to strengthen JBS and make it available to a wider audience of academics, researchers, policy makers, government bodies, development agencies, think tanks, and other individuals and organizations in the country. I look forward to this partnership and feel confident about building JBS into a more analytical and penetrating voice that will help bring about needed changes in the policy environment in Bangladesh, fulfilling its mission and intended purpose more comprehensively.

Syed Saad Andaleeb, Ph.D.
Editor, JBS
Professor and Program Chair, Marketing
Sam and Irene Black School of Business
Penn State Erie
Erie, PA 16563-1400 – USA

SCIENCE AND TECHNOLOGY DEVELOPMENT IN BANGLADESH: FAILURE IN POLICY IMPLEMENTATION

Iqbal Mahmud

ABSTRACT

The socio-economic setting necessary for successful implementation of Science and Technology (S&T) policies in a developing country has been discussed and the concept of “technology culture” introduced. It is posited that the absence of technology culture in a given socio-economic setting makes implementation of S&T policies problematic. Technological resource base in Bangladesh and the low S&T achievement indices for the country, as worked out by some international organizations, are also presented. In discussing the status of existing R&D institutions it has been stated that, with the notable exception of agricultural research, there is absence of organized and well-planned research management systems in several areas. It is argued that even though individuals, national organizations and institutions continue to make commitments to development of S&T, the relative strength of such commitments vary significantly. In most cases the public pronouncements and promises have been without any operational value. The insignificant fraction of total annual development funds that is allocated for R&D activities in some important sectors have been tabulated and presented as conclusive evidence of such lack of commitment. Also, the country does not have appropriate plans to achieve the Millennium Development Goals for S&T as articulated by relevant UN declarations. However, on a more positive note, substantial investments have been made in agricultural research with laudable achievements in cereal production through large R&D investments for over two decades. The critical role of new and emerging technologies like ICTs in raising productivity in various sectors is also analyzed. It is posited that for ICTs to provide impetus to poverty alleviation as a critical economic activity, public resources will have to be invested in developing interdependent infrastructure and appropriate human resource programs. The importance of tertiary level education programs in such efforts has been highlighted. The difficulties involved in achieving S&T development goals through donor-driven and externally-funded import of technology have been pointed out. Finally, it has been emphasized that the task of building local S&T capabilities has to be borne by endogenous leadership through the exercise of determined political will for technological self reliance.

Introduction

In the newly industrializing countries in Asia it has been demonstrated that society’s attitudinal constraints and paucity of human and material resources have been overcome through deliberate policy and planning initiatives which have propelled them through the desired scientific and technological stages of evolution. However, the story has been different for Bangladesh. The sluggish pace of development in Science and Technology (S&T) in this country may be traced to attitudes evolving out of historical events, relative scarcity of human and material resources, and most importantly, the lack of political will which is supposed to set societal goals and objectives and devise rewards and planning systems.

During the last three decades there has been no dearth of policy studies and project proposals for the development of science and transfer of technology in Bangladesh. However, in many cases, these have been mere declarations of intention with little or no operational value. Plans proposed in one mid-term

development plan document were either not implemented or not followed up in the next. Implementing agencies have not adhered to the policy directives regarding choice of technology or have totally lacked the mechanism or scientific manpower to comprehend or appreciate the implications of proper technology transfer. In other cases, only a small part of the total transfer process has been adopted, resulting in stunted growth.

Technology Culture

It would perhaps be appropriate at this point to introduce the concept of “technology culture” (Mahmud, 2005). Technology culture refers to an attitude of individuals in a given socio-cultural environment. The spirit of inquiry and the degree of acceptance of the right to question and be questioned is to be considered fundamental to the development of technological temperament. It calls upon one to seek the “how”, “what” and “why” of everything that goes on in the society. The existence of a technology culture is complementary to the initiative taken by a country in the introduction of productive forces,

which can lead to technological development. A socio-economic entity may decide to develop the object-embodied part of technology (or physical facilities) based on its relevant factor endowments existing at a given period of time. However, simultaneous development of the other three essential components of technology, i.e., person-embodied, record-embodied and organization-embodied components constitute the more innovative and intellectual aspects and presupposes existence of a technology culture in the country. For the sake of simplicity it is assumed that such a culture exists in a well-developed form in all leading industrial countries. However, developing countries like Bangladesh are currently at various stages of acquiring it in a form complementary to their own societal ambience. In this mission to develop a technology culture, they are also engaged in the process of removing some “road blocks”. Some of those “road blocks” or “negative elements” which are probably more significant than others among the myriad of causes of uneven progress in embracing a technology culture are:

- Traditional value system and orthodoxy
- Habits of resignation
- Bureaucratic decision-making systems influenced by donors’ prescriptions
- Education system which discourages nurturing of questioning minds and has inadequate focus on tertiary education

Technological Resource Base of Bangladesh and Current Status

The soil and climatic conditions of Bangladesh are beneficial for biomass production. But the possibility of production of agro-based resources for industries is severely restricted by the high population density. However, the continuing policy of introducing high yield variety (HYV) technology in the food crop sector and augmentation of cropping intensity have left the cash crop sector unaffected by the increasing demand for staple food from the growing population. The variations in the acreage occur mainly due to cyclical demand patterns of the related industry (particularly for jute). Thus, there are hardly any “use-conflicts” for agricultural land and between cash and food crops.

Bangladesh has less than 0.05 acre of forest land per person, one of the lowest such ratio in the world. The decline from 0.09 acre/person in 1968-69 has been primarily the result of a dramatic increase of the

population size. Total state forest area is about 5.4 million acres. Of this, the area under effective tree cover is approximately 2.1 million acres or less than 5.1% of the total land area. Officially, the Forest Department manages nearly 3.6 million acres of forest area.

The country is poor in material resources by regional or global standards. Prospects of metallic ores, found in igneous rocks and, at exploitable depth, are negligible. Other minerals found so far are: natural gas, coal, white clay and glass sand. The total known reserve of natural gas is considered to be about 13 trillion cubic feet (TCF). However, recent gas explorations have indicated that one can count on at least 30 TCF of gas reserve.

Bituminous, non-coking coal has been found in three places in the northern zone of the country: near Jamalganj (Bogra), Boropukuria (Bogra), Boropukuria (Dinajpur) and Pirganj (Rangpur). All three deposits are reported to be quite substantial and widespread. The exploitation of this resource for power generation has begun.

Hard rocks at mineable depths have been found in the northern zone. Plans for their exploitation have been finalized. Glass quality sand deposits have been found at a few locations along the northern and eastern borders where alluvial plains meet the hilly terrains.

In addition to the very low rate of literacy, historically the policies related to human resources in this part of the subcontinent, were directed more towards liberal arts instead of the sciences or technical subjects. Several initiatives have been taken to reorient the education system in the country. Sporadic efforts have been made to develop a type of education which would produce the manpower required to perform the role of forerunner to physical development in various sectors. However, the planned “massive shift towards technical education” envisaged in several mid-term development plans has not taken place to any appreciable degree.

Foreign training of technical personnel is usually a built-in feature in most of the sophisticated industrial and infrastructure projects, especially in those which are externally funded. For post-graduate education and training abroad, professionals usually depend on foreign government-sponsored scholarship schemes or research/teaching assistantships offered by foreign universities. The Government does not have any

significant scholarship schemes for foreign training programs of its own.

S&T Achievement Indices

The recently published Human Development Report of UNDP (2003/4) has listed UN member countries in terms of their achievements in connectivity to world information sources, S&T innovation and R&D investment. Table 1 shows the relevant figures for countries in South Asia. The figures for Bangladesh are not encouraging at all.

Desai, et al. (2001) have proposed a set of composite indices which purport to indicate the achievements of different countries in terms of science and technology development. The TAI (Technology Achievement Index) focuses on four dimensions of technological capacity that are important for reaping the benefits of the network age. The methodology used to calculate the TAI is similar to the human development index: a simple average of the dimensions of the index, which in turn are calculated based on the selected indicators. The TAI has eight indicators, two in each of the four dimensions:

- Technology creation measured by the number of

patents granted to residents per capita and by receipts of royalties and license fees from abroad per capita.

- Diffusion of recent innovations, measured by the number of Internet hosts per capita and the share of high-and medium-technology exports in total goods exports.
- Diffusion of old innovations, measured by telephones (mainline and cellular) per capita and electricity consumption per capita.
- Human skills, measured by mean years of schooling in the population aged 15 and above and the gross tertiary science enrolment ratio.

TAI estimates have been prepared for 72 countries for which data are available and of acceptable quality. For others, data were missing or unsatisfactory (e.g. Bangladesh) for one or more indicators, so the TAI could not be estimated. For a number of countries in the developing world, data on patents and royalties are missing. Because a lack of data generally indicates that little formal innovation is occurring, a value of zero for the missing indicator was used in these cases (see Table 2 below). Once again, lack of pertinent data for Bangladesh is a disappointing feature of the results of the study.

Table 1: South Asia — Connectivity, Innovation and R&D

Country	Internet users (Per 1000 people) 2002	Patents granted to residents (Per million people) 2000	Receipts of royalties and license fees (US \$ Per person) 2002	R&D Expenditure (As % of GDP) 1996-2002	Researchers in R&D (Per million people) 1990-2001
Bangladesh	1.5	N.A.*	N.A.	N.A.	51
India	15.9	0	N.A.	N.A.	157
Nepal	3.4	N.A.	N.A.	N.A.	N.A.
Pakistan	10.3	N.A.	N.A.	N.A.	69
Sri Lanka	10.6	0	N.A.	0.2	191

Source: UNDP. * Indicates lack of data.

Table 2: South Asia TAI Rankings (after Desai, Sagasti, et al.)

Country	TAI Rank
Bangladesh*	NA*
India	63
Nepal	69
Pakistan	65
Sri Lanka	62

* Indicates lack of pertinent data

Research and Development Institutions

The major S&T research activities, except for agricultural research, which could lead to viable technological outputs, are more or less concentrated in the Bangladesh Council of Scientific and Industrial Research (BCSIR). The range of research activities carried out in the Road Research Laboratory, the Housing and Building Research Laboratory, the River Research Laboratory, etc., has been limited. Research activity of the Bangladesh Atomic Energy Commission is primarily in the application of nuclear science and theoretical physics.

Research activities in the agriculture sector are coordinated by an umbrella organization, the Bangladesh Agriculture Research Council (BARC). Its functions include medium and long-term research, planning, organizing and funding coordinated research involving a number of institutions. Some of the component units of the Council namely, the Bangladesh Agriculture Research Institute (BARI) and the Bangladesh Rice Research Institute (BRRI) have their own program planning and review mechanisms. Externally funded projects are usually under constant review.

Other than agriculture, organized review mechanisms have not yet been instituted for R&D activities. In BCSIR, for instance, research program planning has been introduced only recently. Previously, an individual researcher used to select his research projects based on his own judgment. His superiors, who had specialized in the same discipline, made the decision to approve the project. This procedure gave rise to a large number of projects. Similar is the condition of the Bangladesh Atomic Energy Commission. Thus, sub critical levels of manpower and fund allocation are painfully evident for R&D units outside the agriculture sector.

Shortage of competent manpower is identified as the major constraint in R&D institutions. The so called "brain-drain" phenomenon of recent times, attraction for overseas jobs and lack of proper service conditions in the R&D institutes, have all contributed to the shortage of competent scientists, engineers and skilled technicians.

With the notable exception of BARI and BRRI, the absence of organized and well-planned research management systems is common. Consequently, the research efforts are fragmentary, uncoordinated and not generally related to long-term development

objectives. The S&T related publications in the country include about 40 journals/periodicals published by professional societies/associations; 40 (approx.) journals/periodicals published by R&D organizations and several popular magazines published in Bangla and English. With the exception of the agriculture sector, the S&T information network system within the country as well as with the outside world is weak. As a result, the S&T activities and achievement of any single organization is not known to the others.

Professional Societies and Associations

The Ministry of Science and Information and Communication Technology (previously known as the Ministry of S&T) lists about fifty S&T professional societies and associations in the country. Of the professional associations, the following are some of those directly concerned with cross-sectoral implications for S&T: the Bangladesh Academy of Sciences, the Bangladesh Association for Advancement of Science, the Bangladesh Association of Scientists and Scientific Professions, the Bangladesh Agriculturists' Association, the Bangladesh Medical Association and the Institution of Engineers, Bangladesh. Others are single-discipline societies and associations covering the more conventional scientific and technological disciplines. However, the impact of these professional societies and associations in the field of science and technology is not noticeable. A possible reason may be that these associations are more concerned about the welfare of their respective communities, and the development of science and technology is secondary in their agenda. Recent politicization of some of these associations has been greatly detrimental to their growth as worthwhile learned societies.

S & T Policy Development Initiatives in the Past Decades

National Commitment

Implicit reference to technology has been made in the Fundamental Principles of State Policy as embodied in the constitution of the republic. Article 16 of the State Policy mentions:

"The state shall adopt effective measures to bring about a radical transformation in the rural areas through the provision of an agricultural revolution, the provision of rural electrification, the development

of cottage and other industries.”

However laws, acts or ordinances specifically dealing with technological development have not been promulgated in the country. The medium term development plans, concerned mainly with economic policies and investment programs, occasionally mention the relevant technological aspects.

Various individuals, bodies and institutions at different forums often make political commitments to technology for development. However the relative strengths of such commitments vary significantly. One possible classification of political commitments in increasing order of strength is illustrated in Table 3. The illustration shows that there is hardly any commitment above the third level.

The striking features of the mid-term development plans of the country are, (i) absence of continuity and connectivity of the programs envisaged in different plans, and (ii) absence of clearly defined strategies and programs for realization of the envisaged technological objectives.

National Science and Technology Policy

The first attempt towards formulation of a state policy for science and technology was made in 1980. However, due to over-ambitious goals and resource constraints, the draft could not sail through. In January 1985, the Science and Technology Division of the Government of Bangladesh (GOB) circulated another draft National Science and Technology

Policy (NSTP) document. The National Committee for S&T (later renamed as National Council for Science and Technology) subsequently approved the draft for Science and Technology in 1986. [GOB, 1986] The NSTP recognizes that national priority should be the integration of scientific and technological considerations with overall development strategy of the country.

One sub-section of the NSTP deals with the establishment of a national capability for development of indigenous technology and attainment of a national capacity for the assessment, selection, acquisition, adoption and adaptation of foreign technology. With the objectives of developing indigenous technology and efficient transfer of imported technology, it aims to:

- guide the formulation of a Technology Plan which is to be integrated with the National Plan;
- attain national capacity for autonomous decision making in technological matters through promotion of technological competence and self-reliance;
- ensure transfer and utilization of results of research in production sectors of the national economy;
- ensure provision of facilities for transfer and productive utilization of research results through the institutionalization of engineering design, prototype development and commercialization of products in the relevant sector corporations and individual units in both public and private enterprises;

Table3: Levels of National Commitment to Technology for Development

Level	Type of potential Commitment to Technology for Development	Situation in Bangladesh
1 st	Public statement	Frequently made statements indicate awareness of the importance of S&T in national development
2 nd	Published official statements	Official statement on National Science and Technology Policy made in 1986.
3 rd	Statement in planning documents	Commonly found in planning documents and budget speeches.
4 th	Enactment of laws to ensure long-term validity, sectoral compliance and departmental cooperation	Explicit science and technology development laws are not available.
5 th	Inclusion of envisaged S&T development pattern in the Constitution to ensure that frequent policy changes are not there	Not yet implemented.

- reduce vulnerability, particularly in strategic and critical areas;
- devise appropriate legal, fiscal and financial instruments for selection, importation, absorption and adaptation of foreign technology;
- ensure establishment of institutional facilities for relevant knowledge assimilation and skill development for the learning-absorption process for imported technology;
- generate technologies which are internationally competitive, particularly those with export potential;
- ensure development of support facilities like information and documentation services, computer service and soft-ware packages, standardization and quality control;
- ensure proper appreciation of ecological, environmental, energy conservation, employment generation and social justice consideration while importing technology;
- provide support to emerging technologies like biotechnology, genetic engineering, micro-electronics, new and renewable source of energy, etc.

The National Council for Science and Technology (NCST), headed by the Prime Minister, is the apex body to oversee the implementation of Science and Technology Policy in the country. There is an Executive Committee of the National Council for Science and Technology (ECNCST). These apex bodies have rarely met during the last three decades.

As a part of the implementation plan of the National Science and Technology Policy, the ECNCST constituted a committee named “Consultative Committee on Transfer of Technology” (CCTT) in 1987. This Committee suggested a number of action programs and indicated the institutional arrangements for implementing those programs. However, nothing has been implemented yet.

Good intentions are of no use if they are not implemented. S&T policy for the country cuts across many policy areas and development sectors. Absence of any mechanism for implementation and mandatory compliance by different sectors has made the objectives of NSTP a mere set of pious wishes.

Allocation for R&D in Annual Development Plans

An indication of the Government’s commitment to scientific and technological research and

development (R&D) is the fraction of the total annual development funds allocated to R&D activities in various sectors of development. Tables 4a and 4b, which follow, have been prepared by the author on the basis of data available in various Annual Development Plans of GOB as drafted and published by the Planning Commission for two five-year periods, viz., 1980-85 and 2000-05. The tables clearly show that except for the agriculture sector, none of the other areas have received any significant or sustained investments in R&D. Agriculture received considerable funds for R&D during 1980-85 and has continued to do so even during 2000-05. It is now recognized that productivity in agriculture has gained significantly in Bangladesh and the country has gained autarky in cereal production. Given the limited arable land, extreme poverty and poor infrastructure this is a laudable achievement indeed. The author believes that this was possible due to the sustained investments made in agriculture research over more than two decades. Unfortunately this has not happened in other sectors.

The figures for Industry appear to have improved during 2000-05. However, on closer look it was found that the higher figures were due to the much-reduced public sector investments made in industry during the later period (the “denominator” became much smaller!).

Present Modalities of Policy Formulation

Successful industrializing countries in Asia have utilized a judicious mix of policy instruments to achieve high rates of industrial and economic growth. The policy instruments fall into the following broad categories, viz.,

- Infant industry protection measures;
- Credit and input subsidies;
- Encouragement to mature industries to participate in global competition;
- Technology investment led productivity policy.

Of the four stated broad categories of policy instruments, Bangladesh has experimented with the first two. The other two policies have not yet been pursued with any degree of seriousness. However, even the first two measures have not yielded any demonstrable positive results. Some of the basic reasons for failure to achieve an effective policy mix are:

- (a) Productivity did not figure high in the list of

issues to be addressed. Conventional economic wisdom stressed capital formation *per se* (through assumed savings and foreign aid). Changes in design, product improvement, adaptations etc. are possibly considered as “cosmetic”.

(b) Entrepreneurs and parasitical enterprises saddled with protection and subsidies often considered those to be permanent rents or entitlements. In many cases productivity improvements were seen to be threatening to the status quo.

Table 4(a): Percentage of Annual Development Plan allocation for R&D activities (1980/81-1984/85)

FY/Sector	80/81	81/82	82/83	83/84	84/85
Industries	2.20	1.75	2.14	2.20	1.34
Power	Nil	Nil	Nil	Nil	Nil
Natural Resources	0.40	1.03	1.52	1.03	2.3
Transport	0.02	0.002	0.12	1.29	1.25
Communication	Nil	Nil	Nil	Nil	Nil
Health	6.70	6.87	6.06	1.74	3.75
Agriculture	8.70	11.78	6.70	9.57	14.84

Data Source: Annual Development Plans, Planning Commission, GOB

Table 4(b): Percentage of Annual Development Plan allocation for R&D activities (2000/01-2004/05)

FY/Sector	00/01	01/02	02/03	03/04	04/05
Industries	6.90	7.80	9.30	4.70	2.20
Power	Nil	Nil	Nil	Nil	Nil
Natural Resources	0.33	0.20	0.16	Nil	Nil
Transport	Nil	Nil	0.05	Nil	0.06
Communication	Nil	0.05	0.22	0.23	0.54
Health	Nil	Nil	Nil	0.48	Nil
Agriculture	22.48	11.00	9.20	7.07	7.80

Data Source: Annual Development Plans, Planning Commission, GOB

- (c) The modalities of opening the economy to foreign investment have been worked out. However, institutional arrangements for adaptive initiation and technology spin-off are not yet in place. Without such institutional arrangements for initiating an evolutionary “learning-absorption” process for imported technology, the generous open door policy for imported technology will not result in up gradation of in-country technological capability.
- (d) Producing firms do not conduct research and development (R&D) for product improvement, diversification and technology adaptation. “Blue-collar” R&D is being practiced in a disorganized and sporadic manner without a comprehensive policy framework.

Impact of Externally Funded Import of Technology

Many funding agencies recognize that one of the major objectives of developing countries is to strengthen their indigenous technological capabilities, to reduce their growing dependence on foreign technology, and to acquire a greater degree of autonomy in technology choices. However, some agencies even consider such goals as elusive.

The international financing institutions are of the conviction that the main imperative at the project level is that the project itself be successful. The probable by-products or spin-off effects of technology development are less in importance. As such, it is important for them to bear in mind that there is a trade-off between helping to build a local technological capability and getting a particular project on stream. For instance, if a fertilizer project is delayed in order to give design experience to local engineers for incorporating a locally developed technology, they think this will have a direct negative impact on agricultural production. This implies that the task of building local technological capabilities has to be borne by the country itself through the exercise of political will for technological self reliance (GOB, 1991).

In-house technology assessment within the enterprise of a foreign investment proposal is not carried out with its cross-sectoral implications. The recipient agency usually examines the proposal from a narrow departmental perspective, which may not yield desired technological spin-off effects in other sectors. Also the TNCs and other commercial interests who

expect to make a profit out of the foreign funded investment become very influential in the choice of technology and the manner of its import.

The funding agency offering development prospects has its own objectives, formalities and procedures that may or may not find their equivalent in the recipient. Sometimes, Bangladesh's position on the technological implications of a development proposal is either not clearly spelled out or has not been formalized. Thus the funding agency, in its desire to quickly show the result to its own constituents, puts on pressure to have its own way in the following aspects of the program:

- Identification of the type and scale of technology
- Selection of consultants and technical advisors
- Selection of contractor
- Organization of local project management team
- Procurement of hardware
- Process design and implementation program

Another problem area is the uncritical acceptance of foreign funds that often create demand for imported raw materials and intermediate goods for which indigenous substitutes are not sought. This tendency is most common in industries where foreign commodity aid usually involves import of foreign raw materials. Import of manufacturing technology for a foreign consumer sometimes creates demand not only for some specific raw materials but also for a particular type of packaging, which may not be available locally.

Import of equipment or technology from various sources creates another type of sourcing problem for multi-donor projects. In this case, the demand for raw materials or spares becomes so fragmented in terms of specifications that attempts to manufacture these inputs locally are frustrated for lack of a sufficiently large market for any specific item. No technology is rigid or final. The detailed specification of a technology can be altered within a range to make it compatible with locally available inputs. Alterations may require change in product design or specification, change in process engineering as well as some change in the characteristics of the available inputs through further processing.

Thus, efforts of funding agencies to make a lasting effect on the economy of Bangladesh merely consist of transplanting some new technology in the existing socio-economic setting. In the absence of a comprehensive technology-based development policy

with cross-sectoral considerations such transplantsations cannot help achieve the technological goals and expectations of the country.

The Existing State of Technology Transfer in Industry

Available studies on the issue of transfer of technology in various industrial sub sectors of Bangladesh reflect one thing in common: poor capabilities to absorb imported technology. From technology transfer case studies of chemical and fertilizer industries, leather industries, general electrical goods manufacturing, the Bangladesh Diesel Plant and engineering industries (Government of Bangladesh 1991; Huq et al. 1993; Haque and Islam 1997; Mondal 1998), it is observed that there are shortcomings in both planning and implementation stages, which affect technology transfer processes both in public and private sector industries. Activities like assessment in the preparation stage for development of the acquired technology are not exercised in its true sense. For other major activities, except operation and maintenance, there is a dominance of foreign S&T capability in public sector industries. In the private sector these activities get much less importance. Performance of industries, irrespective of ownership, is at best successful in operation and maintenance. In some cases even this is limited by market constraints. In technology transfer measures this is the static state (as opposed to a dynamic state) of technology transfer. A notable exception has been KAFCO, the only large chemical fertilizer plant in the private sector, which has been able to reach production targets 15-20% above the nameplate capacity in recent months due to introduction of process changes and technical improvements that were initiated, planned and implemented by local engineers. Being in the private sector, the engineers in the plant (along with other relevant professionals) are now able to initiate investment decisions that are not subject to scrutiny by layers of bureaucracy as in case of the public sector.

The leather manufacturers at the medium and large-scale level are found to be reasonably well acquainted with technology. This is due to a number of factors. First, some of them are closely in touch with foreign customers and emerging technologies. Second, about a dozen entrepreneurs have been in business for over twenty years. Third, the size of the industry is reasonably big with over 200 establishments, including three dozen or so large or

medium-scale plants. Finally, the leather manufacturers themselves have locally made a number of simple types of machinery for four decades, and some form of technological capability, at a moderate level, has already been achieved.

Poor performance in planning and implementation of technology transfer is thought to be either due to lack of capability or due to non-utilization of available capability. It appears that the following activities were not pursued properly and as such successful transfer of technology has been constrained to a great extent: (a) feasibility study; (b) technology assessment; (c) negotiation for technology; (d) marketing (assessment of market and organization of production according to market demand); and (e) adaptation and development. In the private sector, entrepreneurs are not aware of the benefit or the cost of such assessment, and as such reluctant to invest in this activity.

Emerging Technologies and Productivity

The new and emerging technologies and progress in science and technology have raised hopes in developing countries because, most of them being scale neutral, the hurdle imposed by "economies of scale" can be surmounted in smaller economies. Especially, modern information and communication technologies (ICT) are believed to hold great promises for these nations. Academics, policy makers, politicians and entrepreneurs alike often claim that ICTs represent one of the most powerful tools in the fight against poverty. In Bangladesh, the Ministry of Science and Technology has recently been renamed as the Ministry of Science and Information and Communication Technology. Presumably this was done to demonstrate the Government's heightened commitment to the ICT sector. A new ICT Policy has been published. Unfortunately, in the process, this ministry seems to have lost the holistic view of "Technology" which cuts across all sectors of development.

However, the role of ICTs in helping a developing country leapfrog into the domain of new and emerging technologies remains paramount. Improved access to markets and supply chains, broader base for decision making, increased civil society participation in political decision making processes and expanded reach and accessibility of government services seem to provide good reasons for such claims. Introduction of *Village Phone* (with readily available micro credit) in rural areas have

shown that mobile phones can have significant positive social and economic impacts, including large consumer surpluses. However it is also recognized that for ICTs to provide impetus to poverty alleviation as a "stand alone" economic activity, public money will have to be spent - which in turn means that there are important trade offs to be considered (Caspery, 2002). It needs to be emphasized that ICTs by themselves will solve no problems (of poverty) if the infrastructure necessary to use them is missing. The necessary infrastructure is not just electricity, roads, telecommunication facilities, but also, general literacy and ability to use computers and overall improvement in human resource development programs (Patel, 2002). Given such trade-offs, it is essential to select which kinds of ICT access delivers the best value for money. It has been demonstrated that the developing countries that have built, in the last decades, a large manufacturing base and the necessary infrastructure to support it gained most in productivity when the critical new input of ICTs was added to existing production activities. However, as the following discussion will try to argue, opportunities abound for scientist, technologists and engineers to make the new and emerging technological "forces" work for raising productivity and attack poverty.

Appropriate Technology for Bangladesh

The new and emerging technological "forces" at the command of the scientists and engineers of the 21st century may, at first sight, seem to be distant dreams for Bangladesh. During the 1970s poor developing countries were advised to adopt *intermediate technologies* in place of modern technologies. Case studies of inappropriate applications of modern and advanced technologies were published and presented all over the world to prove that modern technologies were not our "cup of tea"! Intermediate technologies were prescribed for us. Unfortunately it was often not realized that the so-called intermediate technologies, offered as the appropriate ones, in many cases represented technological dead ends without any innate dynamism normally associated with technologies that help a country to go up the ladder of productivity. Higher productivity, after all, is the key element that provides the comparative advantage over others in this increasingly competitive world. The poor remain poor when tools and techniques, which can raise productivity, are denied to them. During the 1970s the so-called advanced technologies considered to be inappropriate for the poor belonged to the era of earlier technological

revolution. The nature of the new technological "forces" being unleashed during the present century is such that most of them are scale neutral and amenable to be custom made to suit a particular need irrespective of size of application. Additionally they are not resource degraders. In fact many are resource enrichers (e.g. Biotechnology). Thus this century will be a unique period of human history when scientist, engineers and technologists of both poor and rich nations will have at their command almost identical S&T "forces" to raise productivity (Mahmud, 1996).

Millennium Development Goals (MDG) for S&T and Case of Bangladesh

In assessing the MDG status in Bangladesh, the Government of Bangladesh (GOB) Poverty Reduction Strategy Paper (PRSP) (GED Planning Commission, 2005) essentially addresses the targets to be achieved with respect to poverty reduction, reduction in population growth, decrease in child mortality, increase in child nutrition, gender equality, primary education, etc. These issues are perceived to be directly related to reduction of poverty. For the tertiary education sector PRSP recognizes that it needs fundamental overhaul with respect to overall governance. It admits that participation of only 7 out of every 1000 persons in higher education in today's "knowledge economy" and "information society" is meager. Of these seven only a fraction go for Science and Engineering disciplines. Thus the real situation, as far as S&T is concerned, *is really alarming*. However, no large investment has yet been planned in this sector that could be considered to be a major policy shift from "business as usual". In the "Policy Matrix" of PRSP, actions to be taken in areas of ICT and Biotechnology have been enumerated. However, the wide-ranging policy initiatives and aggressive programs for the development of Science, Technology and Innovation as proposed by the S&T Task Force of the UN Millennium Project have not been incorporated. This is a disappointment for those in Bangladesh who dream of national initiatives similar to those taken years ago in China, East Asian countries, India and, more recently, in Tunisia.

In a document (GOB and UN, 2005) jointly prepared by the Government of Bangladesh (GOB) and the local UN office, the goal and target of the MDGs regarding need for application of S&T in development activities in the new millennium has been stated. Unfortunately, it only elaborates on strategies for attaining the numbers, *per se*, of telephone lines, Internet connections and personal

Table 5: Adjusted years of education per person aged 15-64, 1950-92

Year	Korea	Taiwan	China	India	Japan	UK	USA
1950	3.36	3.62	1.60	1.35	9.11	10.84	11.27
1973	6.82	7.35	4.00	2.60	12.00	11.66	14.58
1992	13.66	13.83	8.50	5.55	14.86	14.09	18.04

Source: Maddison 1998, Primary education is given a weight of 1, secondary 1.4, and higher 2.

computers in use. There is no reference to the work of the UN Task Force on S&T or its recommendations. One at least expected this GOB-UN document to take cognizance of those recommendations set forth in the UN Task Force report. There should have been a "Situation Analysis" of the Bangladesh scene with respect to the S&T issues raised in the UN document.

The World Bank document (World Bank, 2005) on achievement of MDG in Bangladesh does not mention anything regarding Science, Technology and Innovation issues in the country. It only deals with goals that directly relate to poverty reduction *per se*.

It praises the GOB for spending less than India on education at the tertiary level (India-20.3% and Bangladesh-11.1% of public spending on education). This praise has been sadly misplaced. The stark reality is that without a determined stress on scientific and engineering education at the tertiary level, no country can hope to be a part of the global knowledge village. India and East Asian countries have done well to ignore such prescriptions for reduction of spending in the tertiary sector. (Mahmud, 2005)

Table 5 shows the progress on the educational level of the labor force in the newly developed, as well as the developed countries. The figures demonstrate the validity of the arguments made above in favor of tertiary education for Bangladesh. The low figures for China and India reflect the lower levels of their achievement in narrowing the knowledge divide. The remarkable strides made in this respect by Korea (Rep. of) and Taiwan through large investments in tertiary education is quite evident.

Conclusion

The task of science and technology policy making and its proper implementation is complex, and it is compounded even further in this country due to severe resource constraints, rising expectations and

exogenous influences on the planning process. The extent and speed at which science and technology can contribute to national development depend, in large measure, on the policies pursued and actions taken outside the individual research and production systems.

The probable reasons for slow implementation of S&T policy in Bangladesh are:

- (a) The country never had a technology plan as a complement to the national development plan (with the notable exception of the agriculture sector). Serious commitments to S&T development and investments in R&D have not been made.
- (b) Sectoral plans have often been formulated without taking cognizance of the impact of technologies involved and their cross-sectoral implications. Other priorities have taken precedence over technology.
- (c) Technology transferred or imported from abroad in various sectors has remained in "static" forms. The recipients often lacked institutional mechanisms in the form of appropriate R&D institutions to utilize "dynamic" components of a foreign technology to derive maximum benefit from its spin off effect.
- (d) National scientific and technological goals, even if articulated in S&T policies and development plans, are not taken into cognizance during formulation, appraisal, monitoring and evaluation of projects.
- (e) In the absence of a deliberate policy for technological self-reliance, the technology decision-making process is influenced by the value system and personal preference of the diverse institutions and individuals who in many cases have to contend with the dominance of outsiders in foreign assisted projects.

- (f) Neglect of the tertiary sector of education has inhibited growth of appropriate human resource base for S&T development. Public universities have been subject to budget cuts in order to augment primary and secondary education (*as per donor prescriptions*) and the private universities are yet to be serious about developing of scientific and technological disciplines.

It is obvious from the above observations that application of science and technology and development processes have not been organically linked. For such linkages new initiatives are to be taken. Without such an effort, S&T policy declarations will remain devoid of operational value.

However, there is a ray of hope. Food grain production is one area in Bangladesh where planned and determined R&D policy initiatives and sustained investments have resulted in positive transformation. Intensive efforts based on local R&D have led to the development and diffusion of improved technologies for food grain production. Such opportunities exist in other sectors as well. There are areas where facilities exist but are being underutilized. There are other areas where similar policy initiatives and appropriate investments can usher in new opportunities to raise productivity. The food grain sub-sector shows us the way. It can be emulated in other sectors as well if the political will is there.

References

Caspery, George, (2002), "Information Technologies to Serve the Poor", D+C Development and Cooperation, OECD. Quoted in Grameen Dialogue, Dhaka.

Desai, M. et al., (2001), "Measuring Tech. Achievement of Nations and the Capacity to Participate in the Network Age", Report developed for the Human Development Report 2001, UNDP.

General Economics Division, Planning Commission, (2005), "Unlocking the Potential", National Strategy for Accelerated Poverty Reduction, Government of the People's Republic of Bangladesh.

Government of Bangladesh and the United Nations Country Team in Bangladesh, (2005), "Millennium Development Goals, Bangladesh Progress Report", GOB-UN.

Government of Bangladesh, (1986), "National

Science and Technology Policy", Dhaka.

Government of Bangladesh, (1991), "A Report of the Task Force on Technology", Planning Commission, Dhaka.

Government of Bangladesh, (1981-85,2001-05) "Annual Development Plans", Planning Commission, Dhaka.

Haque, M.M. and M.N.Nazrul Islam, (1997), "Promoting Industrial Competitiveness through Technological capability Building in Bangladesh", Mimeo, IAT, Bangladesh Univ. of Engg. &Tech., Dhaka

Huq, M.M. et al, (1993), "Machinery Manufacturing in Bangladesh", University Press Limited, Dhaka.

Maddison, A. (1998), "Chinese Economic Performance in the Long Run", OECD, Paris.

Mahmud, I., (2005), "Influence of Some Cultural Issues on Intellectual Capital Formation in Asian Regions", Knowledge Café V, Leon Kozminsky Academy of Entr. and Mgmt., Warsaw.

Mahmud, I., (2005), "Science, Technology and Innovation-MDG-A Bangladesh Perspective", Engineering for Millennium Development Goals, The Institution of Engineers, Bangladesh, Dhaka.

Mahmud, I., (1996), "Profession of Engineering in the 21st Century", Keynote paper, National Seminar on Direction of Engineering Profession to the 21st Century, The Institution of Engineers, Bangladesh, Dhaka.

Mondal, A.H., (1998), "Technological Competitiveness of Leather and Leather Goods", BIDS Studies, Dhaka.

Patel, Kumar, (2002), "The Role of Science and Technology in Small and Medium Enterprise Development", (from the Internet).

United Nations Millennium Project, "Forging Ahead", and "Executive Summary", Report of the UN MDG Task Force on Science, Technology and Innovation, (from the Internet).

World Bank, (2005) "Attaining the Millennium Development Goals in Bangladesh", Human Development Unit, South Asia Region, The World Bank.

Dr. Iqbal Mahmud
Former Vice-Chancellor
Bangladesh University of Engineering and
Technology (BUET)
Dhaka-1000
Bangladesh

Commentary

Munir Quddus

Introduction

I would like to commend Dr. Iqbal Mahmood for his excellent analysis of an important problem, namely, the lack of a coherent strategy or master plan (and poor implementation of the existing plans) for building a sound Science and Technology (S&T) infrastructure in Bangladesh.

The negative implications of this failure in national policymaking are profound. Despite the recent success of Bangladesh in terms of GDP growth, exports earnings, and direct foreign investments, the question remains if the country could have done much better in these and other indicators of economic progress. Most commentators would agree that Bangladesh's economic development could be more stable and sustained if it were built on a solid foundation of a highly-educated workforce, a quality educational system (especially in math and science), and supportive policies that provide the necessary foundation for a modern science and technology-based economy.

Although the problem is one of leadership, the solution is necessarily multi-faceted. A determined and progressive national leadership must work to change the culture, to improve the quality of higher education, to establish management processes, to seek alliances with the international scientific community, and to create private and public sector partnerships for achieving the desired results.

The Main Thesis

The main points made by the author include:

- Despite the existence of some plans (NSTP-1986, MDG-2005), the implementation of Science and Technology policies has been largely ineffective.
- Above all, this is the result of the absence of visionary political leadership in the country.
- Bangladesh today lacks a “technology culture.” This is both a cause and effect of the failure to set the appropriate agenda for science and technology policies at the national level.
- There is a dearth of sound management processes that would provide support to technology generation, transfer, and diffusion in the economy.

- A cursory look at the national budgets over the past two decades presents ample evidence to support this thesis that science and technology issues have been neglected.
- The high degree of confidence placed by politicians in the new technologies (ICT) may not be fully justified. There is no “silver bullet” that will solve the broader problem of a lack of comprehensive plan and poor implementation in this arena.
- On a positive note, if the political will is there, the solution to this problem is within the reach of the country. In at least one sector of the economy, namely agriculture, Bangladesh has demonstrated that it is able to solve a national problem (food deficit) through sustained R&D investments resulting from the development and implementation of progressive S&T policies.
- Through a “determined political will for technological self-reliance” the nation can solve this problem.

Commentary – Areas of Agreement

I am in full agreement with how Dr. Mahmood has identified and analyzed the problem in his informative and critical essay. As a lifelong academic (faculty and senior administrator) in the premier science and technology institution in the country (BUET) who has had the rare opportunity to serve government in a leadership policy-making position, the author is uniquely qualified to analyze this problem. In my view, Dr. Mahmood has the head and the heart to not only correctly identify the problem but also to play a major role in finding a satisfactory resolution to it.

In this section I will comment on a few areas where I agree with the author. The next section will offer a few suggestions to improve the analysis and presentation in the paper.

First, let us discuss the role of higher education both as part of the problem and of a possible solution. In Table 5, the author presents data on “years of education” as a proxy for investment in higher education for citizens in several nations – Korea, Taiwan, Japan, the United Kingdom, the United States of America, India, and China. The data reveal that successful Asian economies have invested heavily in higher education to build their human capital and to catch up with the more mature economies. The author alludes to the fact that these trends reveal policies that are somewhat in conflict

with the recommendations made by some international organizations (World Bank) and donor agencies. The mantra is that developing nations should direct more funds to primary education by reducing support to higher education (tertiary sector) if necessary. This recommendation is short sighted and misleading. In my view, given the critical importance of an educated population, the correct strategy for a developing nation is to invest heavily in *both* primary and higher education. This can be done by cutting back expenditures in defense and other unproductive sectors, and through additional borrowing where necessary. Given the importance of human capital (an educated workforce), public sector support for the education sector, at all levels, is worth the short term price in terms of higher deficits, etc.

Most economists agree that there is no better example of a “public” good deserving of state support than education. Yes, the private sector must play a role in offering education since education also has “private” benefits. However, given its public good properties (your education benefits me and other citizens), it is important that the state in a developing nation play the leading role in funding education even if it results in increased borrowing or higher taxes.

In the context of Bangladesh, given the gridlock (session jam, politicization of administrative appointments, violent student politics, etc.) and shortage of seats in public universities, the 1993 Private University Act was an important piece of legislation that, for the first time, opened higher education to the private sector. From a single university in 1993, The North South University, today Bangladesh has experienced a flowering of private institutions of higher learning with over 57 in operation (according to the last count) with the Education Ministry’s approval. However, simply opening the door to private capital and investment to establish private (non-profit) universities should be only the first step. A strong state can do much more to build a strong private presence in higher education by providing support in the form of subsidized land for building campuses, financial aid and scholarships to students attending these universities, creating the necessary mechanisms (accrediting bodies) to root out low-quality and fraudulent institutions, assisting the institutions to better respond to national priorities (programs in science and technology) instead of responding only to the immediate market demand. Education in science and technology in private universities should be subsidized to attract top students to these fields.

The author states that the private universities “are yet

to be serious about the development of science and technology disciplines.” Neither the public nor the private university sector in Bangladesh has been able to deliver on the promise of producing a sufficiently large number of highly-trained graduates in science and technology disciplines. In my view, the dynamic private university sector in Bangladesh does have the potential to play an increasingly important role here. After offering programs in the soft areas (English, business) that are less costly, the best private universities have begun to offer degrees in engineering, architecture, and other areas in the sciences. Informal discussions with officials from BRAC University and United University, which offer degrees in engineering and science-related disciplines, seem to indicate that there is no scarcity of qualified students and demand for such programs.

The author makes the point that the private industrial and manufacturing sector has promise in the development of science and technology. However, without the necessary investment by the public sector to provide the necessary complementary goods, the private sector will have limited success. The case of KAFKO, a chemical fertilizer plant that has been profitable because its engineers and managers had the ability to respond, is mentioned. However, the author considers this to be an exception to the rule. I agree that the role of the public sector in providing the minimal supply of “public goods” in a free market economy is crucial. Without a stable supply of electricity, good transportation infrastructure, macroeconomic stability, and law and order, the private sector would be seriously constrained in reaching its potential in terms of producing and delivering products that require technology. The state cannot shirk this responsibility and expect the free market to be successful. A highly polarized political environment, bureaucratic mismanagement, and corruption that plague the government in Bangladesh, have all contributed to “soft” or ineffective government policies in the science and technology arena as well as others.

Points That Need Re-Emphasis

First, as an economist, it seems to me that the paper underplays the potential role of foreign direct investment, especially when this results in the construction of new factories and transfer of technology. The 2004 decision by TATA of India to invest \$2 billion in the power, fertilizer, and steel factories was exciting news for Bangladesh. The significance of such investment should not be underestimated. The author does not provide historical or comparative statistics that would show

that foreign direct investment has been on the rise and has had a positive impact on the economy in the science and technology related sectors.

To give one example of the potential impact of foreign investment and partnerships, it should be remembered that the readymade garment export industry had modest beginnings in a joint venture between Daewoo (South Korea), and Dosh Garments (Quddus and Rashid, 2000). The agreement covered marketing as well as production and training of supervisors in Daewoo's Pusan factory, at the time one of the largest in the world. The collaboration was so successful from Bangladeshi partner's perspective that, in less than two years, Dosh Garments walked away from the agreement to set up its own factories and export business. Some of the supervisors and managers working for Dosh Garments who were trained in Korea eventually left to start their own garment manufacturing and export businesses. The rest is history. The initial efforts spawned an entire industry. Today, with over \$8 billion in export, the RMG sector is the largest foreign exchange earner in Bangladesh. This success disproves the views of many in the academic circles who predicted that the end of MFA would be disastrous for this industry. These commentators underestimated the power of indigenous entrepreneurs and free markets. The very large multiplier impact (forward and backward linkages) a booming industry like the RMG export has on the rest of the economy is also generally underestimated.

Second, the state of higher education needs to be emphasized. It seems to me that the damage that has been done to public universities in Bangladesh by student politics and widespread politicization will cost the nation dearly in terms of a lost generation of engineers and scientific talent. The lack of high-quality public higher education has resulted in an exodus of a large number of scientifically-talented students and faculty members from the country. The negative impact of this lost talent should be discussed. With reference to Pakistan's higher education, Pervez Hoodbhoy, the MIT trained physicist and a student of Professor Abdus Salam, describes the sorry state of science and math education in the public universities in Pakistan (Hoodbhoy, 2000). The situation in Bangladesh may be somewhat better, but many of the problems are common in the public universities in both countries. These include, politicization of faculty recruitment, appointments and promotion processes, dysfunctional tenure system, absence of accountability for performance, lack of resources for books and equipments, low number of graduate degrees

awarded in science disciplines, poor quality of instruction and learning, and student admission based on quotas instead of merit only. Comparing the performance of Pakistan with India, he finds Pakistan is steadily falling behind in math and science (higher) education. For example, in 1989-1990, Indian universities produced approximately 2,500 doctorates in the scientific disciplines compared to less than 25 for Pakistan. In this matrix, the public universities in Bangladesh have probably fared even worse. However, reforming higher education in science and technology is still possible. We must take steps to build up our flagship universities as centers of R&D, attract our most talented scientists back to the country, and take other steps to inculcate a technology and science culture in the nation. Additionally, we must invest heavily in vocational schools that will teach the basics of science and technology to support a modern economy. A national S&T strategy should also focus on how the talents of the expatriate Bangladeshi scientific community can be tapped. We do not have to reinvent the wheel as other nations have successfully implemented policies to reverse the brain drain.

Third, in terms of solutions, others have pointed out that higher education and the private sector must collaborate in the area of science and technology (Majumdar, 1996). The state alone cannot be expected to carry the full burden of this, or any other strategy. There is a lot that the private sector, the civil society leadership in the arena of science and technology, the academia, and the expatriate community can contribute. Whatever basic research is undertaken in Bangladeshi universities and R&D organizations, these are not coordinated with the needs of local businesses and industries. As a result, industries depend on foreign experts to solve their problems. The two sectors should communicate and interact to develop need-oriented technologies. This is true for the oil and gas sector where there is great potential for indigenous technologies.

Fourth, it seems to me that Bangladesh must identify its core competencies and comparative advantage in the context of the global economy of the 21st century. Once that is achieved, a partnership of the public and the private sector should be forged to achieve the goals in these sectors. The success of Grameen Bank in technology oriented areas (Mobile phone), in which the Bank had no previous expertise, is an interesting model in social entrepreneurship, public-private partnership, as well as in technology transfer and dissemination.

Finally, what about the new (NEXT economy)? The

author refers to the potential of information and communications technologies to help developing nations leapfrog the intermediate stages of industrialization. Tom Friedman in his new book *The World is Flat* makes the compelling argument that new technologies have resulted in a new world economic order which should force us to reconsider the traditional paradigms, and business and economic models. If anything, these trends have reinforced the need for rapidly developing a science and technology infrastructure (citizens, workforce, culture, institutions, policies, other) since the global economy is moving very quickly.

Conclusion

Dr. Iqbal Mahmood has critically analyzed the failure in national policymaking in the area of science and technology. Without a comprehensive master plan based on a national dialogue and a firm political commitment, the national economy will not be able to take advantage of the modern technologies and the global economy. Bangladesh will fall behind other developing nations, who are investing heavily in their science and technology infrastructure, especially in the education of their citizens. On a positive note, Bangladesh does not have to reinvent the wheel. Those in policy making positions can learn much from the successful model followed in the agriculture sector that has resulted in self-sufficiency in food production.

References

Friedman, Thomas, *The World is Flat: A Brief History of the Twenty-First Century*, Ferras, Strauss and Giroux, New York, 2005.

Hoodbhoy, Pervez, "On Reforming Science Education in Pakistani Universities," in J. Talati,

C.W. Vellani, P. Herberg, R. Sutton, A. F. Qureshi, S. Pardhan, K. Bacchus (Edited) *Higher Education – A Pathway to Development*, The Aga Khan University and the Oxford University Press, Karachi, 1998.

Khan, M. Mahmud, "Technological Development in Bangladesh Agriculture," Salim Rashid (Edited) *Bangladesh Economy: Evaluation and a Research Agenda*, UPL, Dhaka, 1995.

Mahmood, Iqbal, Science and Technology Developments in Bangladesh – Failure in Policy," *Bangladesh Development Studies*, this issue.

Majumdar, Sabir, "Potential Collaborations Among Bangladeshi Scientists in North America and their Counterparts in Bangladesh," in A. Ali, M. F. Islam and R. Kuddus (Edited) *Development Issues in Bangladesh*, UPL, Dhaka, 1996.

Quddus, M. and Salim Rashid, *Entrepreneurs and Economic Development: The Remarkable Story of Garment Exports from Bangladesh*, UPL, 2000.

Yunus, Muhammad, *Banker to the Poor: Micro-Lending and the Battle Against World Poverty*, PublicAffairs, 1999.

Munir Quddus is a Professor of Economics and Dean of the College of Business, Prairie View A&M University. The paper has benefited from comments from Dr. Rahim Quazi and Dr. Salim Rashid. The author alone is responsible for the views expressed in this paper. He can be reached at muquddus@pvamu.edu

Commentary

Nazrul Islam

In the face of rapid globalization, liberalization and privatization, technology has become a strategic variable for economic development and competitiveness. In this background, the article, “Science and Technology development in Bangladesh–Failure in Policy Implementation” by Professor Iqbal Mahmud deserves special attention. While deliberating policy implementation, the author has touched upon the issues of technology temper, technological resources, research and development institutions, S&T policy development initiatives, externally funded projects, emerging technologies, and finally the initiatives of Bangladesh to meet the Millennium Development Goals.

At the very beginning of his article, referring to the newly industrialized countries in Asia, the author states that deliberate policy and planning initiatives could lead a country to attain desired scientific and technological change. Science and Technology policy initiatives and their devoted implementation in countries like Korea, Taiwan, Singapore and Malaysia bear testimony to his conviction. However the realization among the leadership of the country of the importance of S&T development for achieving economic progress and competitiveness is a precondition. The leadership of the newly industrialized countries in Asia understand this clearly. For example, the active industrialization effort of Korea, together with the development of science and technology, began with the First Five Year Economic Development Plan launched in 1962. From this first stage of industrialization, the Korean Government fully appreciated the role of science and technology as the driving force for economic growth. Therefore, from the very beginning, they duly emphasized technology development initiatives.

The issue of technology culture and technological temper of the society is also vital. In Bangladesh, there are a number of roadblocks in embracing a technology culture. Some of them, as mentioned by the author, are: traditional value, habit of resignation, bureaucratic decision making system, education system, etc. However, the leadership of the country can adopt a proactive role in promoting the technology culture of the country. In Korea, for example, when they needed highly skilled technicians, the government made it a point that the highest level vocational training certificates (Master Craftsman) would be given by the President of the country. This helped to change the attitude of the

people towards technical skills, as the President of the country did not give Ph.D. certificates.

In his deliberations about the technological resource base of Bangladesh, the author indicated the low level of literacy in the country. He further added that historically the policies related to the human resources in this part of the Indian subcontinent were directed more toward arts than sciences or technical subjects. It may be mentioned that in contrast, Japan recognized the importance of science and technology education long ago during the Meiji Restoration period and was documented explicitly in the country’s constitution¹.

For post-graduate education and training, Bangladesh Government does not have any significant scholarship scheme of its own. Professionals usually depend on foreign government-sponsored scholarship schemes or research/teaching assistantships offered by the foreign universities. In the 21st century when the world has entered into the knowledge economy, human resource development has become a prime concern for all countries. Countries like Vietnam and Pakistan are moving aggressively in this respect. The government of Pakistan has established the “Higher Education Commission” that looks after university education. The main idea is to get rid of the bureaucratic norms of the Ministry of Education. The government is spending huge amounts for scholarships for post-graduate education. The salary structure of the university professors have been separated from others and were raised considerably². Vietnam is also moving aggressively for developing its human resources: not only the central administration, but also the local bodies are spending huge amounts on scholarships for higher studies. For example, Ho Chi Minh City Corporation of Vietnam has taken a project called “Project 300” where it would give scholarships to 300 persons for Masters and Ph.D. degrees in selected universities around the world during a period of 5 years³.

While discussing the S&T achievement indices of Bangladesh, the author has indicated non-availability or non reliable data. The author has not mentioned whether he attempted to collect data from the local sources or not for Tables 1 & 2. By entering into the web sites of the organizations responsible for collecting, compiling and analyzing the data in Bangladesh (i.e. BANBEIS, BANSDOC etc.), one can hardly find any up-to-date information there. BANSDOC conducted a study to estimate the S&T achievement indices in 1995⁴. I am not aware of any further study updating the indices after that. We need to know our position for devising strategies and

policies for advancement.

Research and Development (R&D) activities other than in the agricultural sector are negligible. Sub-critical levels of manpower and fund allocation are painfully evident for R&D units outside the agricultural sector. It can be seen from the tables of R&D allocations in various annual development plans (Tables 4(a), 4(b)) that there is no consistency in R&D allocation except for agriculture. This inconsistency may indicate either or both of the following: one, lack of vision and strategy for the development of the sector. So decisions are taken on ad-hoc basis; two, leadership does not realize/appreciate the importance of S&T for economic development. One needs to invest in R&D consistently. Then only could the benefits be seen. Bangladesh has achieved considerable technological advancement in the crop sector because of the consistent investment in R&D in this sector.

National Science and Technology Policy (NSTP) came into existence in 1986. After 20 years of adoption of the Science and Technology Policy, the country does not have any mechanisms for its implementation. The author mentioned, "Good intentions are no use if they are not implemented". One may go even further and ponder, is there at all any good intention of the leadership of Bangladesh behind these policies? Otherwise, how is it possible that the apex bodies such as the National Council for Science and Technology (NCST), headed by the Prime Minister and the Executive Committee of the Science and Technology (ECNCST), have rarely met during the last three decades?

The author indicated that the modalities of opening the economy to foreign investment have been worked out. However, institutional arrangements for adaptive initiation and technology spin-off are not yet in place. Foreign investment helps a lot in bringing technology to the country. However, national initiatives for assimilation of the technology is a necessary condition to get the desired spin-off effects.

While discussing the impact of externally funded projects, the author indicated that the funding agencies backing a development project have their own objectives, formalities and procedures that may not be conducive for technology transfer and capability development. Bangladesh's position on the technological implications of a development proposal is either not clearly spelled out or has not been formalized. Thus, the funding agencies in their desire to quickly show the results put pressure to have their own way. Here arises the question of clarity of the

objectives and doing the homework for that purpose, which is lacking in Bangladesh.

When, in general, there is a low level capability to absorb imported technology, it is heartening to know the notable exception of KAFCO where introduction of process changes and technical improvements were initiated, planned and implemented by local engineers. And the result is that of reaching a production target 15-20% above the nameplate capacity. This indicates that the talents are there in many areas. What is needed is to establish a proper policy environment that would encourage the people to innovate.

While discussing the emerging technologies, the author mainly discussed information and communication technologies (ICT). Bangladesh has an ICT policy, and the Ministry of Science and Technology has been renamed as Ministry of Science and Information and Communication Technology. I fully agree with the author that unfortunately, in the process, the ministry seems to have lost the holistic view of Technology that cuts across all sectors of development. It is very encouraging that the Government is giving considerable importance to the development of ICT. However two points are to be remembered. First, ICT literacy is more than general literacy. Second, in the mega-merger process, computer, telecommunication and multi-media are merging together. It is high time to recognize it and take this into account in policy planning and implementation.

Poverty Reduction Strategy has been emphasized in meeting the Millennium Development Goals (MDG) in Bangladesh. Primary education has been emphasized as part of the poverty reduction strategy along with others. However we can see the genuine frustration of the author, when the government did not incorporate (or even recognize) the wide-ranging policy initiatives and aggressive programs for the development of science, technology and innovation proposed by the S&T Task Force of the UN Millennium Project. Even the situation analysis of the Bangladesh scene with respect to the S&T issues raised in the UN document was not carried out before exclusion. This indicates the commitment of the leadership for the development of S&T. The author has presented different levels of commitment in Table 3. Perhaps the commitment of the leadership of Bangladesh is still in the border line of 2nd and 3rd level.

The author has referred to the World Bank document where it has praised GOB for spending less than

India on education at the tertiary level. Definitely this praise has been sadly misplaced. Bangladeshi policy makers should not heed such praise. The author has rightly indicated that India and East Asian countries have done well to ignore such prescriptions for budget reduction in the tertiary sector. Without a determined bid to improve scientific and engineering education at the tertiary level it would be difficult to take part in the global knowledge economy.

The paper has raised a number of issues that the leadership of Bangladesh and policy planners should take into consideration. They need to recognize, realize and appreciate the role of technology for national economic development and competitiveness. Only then will effective implementation of the S&T policies take place. It seems from the paper that the leadership of Bangladesh is yet to realize/recognize it. We hope, in the near future, that the leadership will realize and appreciate the role of technology for economic development, leading to the rapid development of S&T in Bangladesh.

ENDNOTES

1. Vogel, E.F.; Japan as No. 1; Charles E. Tuttle & Co., bunkyo-Ku, Tokyo, 1979
2. Personal communication. HEC is sending university teachers and researcher to AIT every year.
3. Personal communication. We have students from Vietnam under this project.
4. BANSDOC; Survey of Research and Development activities in Bangladesh, 1995

Nazrul Islam, PhD

Professor

Coordinator of Management of Technology

School of Management

Asian Institute of Technology

P.O. Box - 4 Klong Luang

Pathumthani 12120, THAILAND

Commentary

Ashraf Ali

Introduction

Dr. Mahmud discusses a number of important issues related to science and technology (S&T) development in Bangladesh and exposes the reasons behind the failure in S&T policy implementation in the country. In particular, the author deals with the following issues in his paper: the current status and past history of S&T development efforts, the relationship of S&T development to dynamic growth in human productivity, the role of research and development (R&D) institution building, the failure in S&T diffusion/transfer through externally funded projects, the failure to learn the real lessons from the experiences in the newly industrialized countries (NICs) in Asia and the inappropriateness of so-called appropriate technology for developing countries.

The objective of this review is to delve deep into a number of issues discussed in the paper and shed light on their competitive market and political-economic implications. It is hoped that some of the real reasons behind the failure in S&T policy implementation will become clearer in the process.

Political Economy of S&T Development: Policy Failure in Bangladesh

The paper identifies lack of commitment from individuals and Bangladeshi national organizations on the need to develop science and technology in the country. In particular, it correctly notes the lack of “operational value” of these commitments because S&T cannot be developed and sustained in a vacuum without the presence and active participation of domestic industries.

This dilemma can be posed as a question: “which comes first—the chicken or the egg?” That is, should S&T be developed first, followed by the creation of domestic industries that will utilize and implement developed S&T? Or, would its reverse be more close to the truth? That is, should efforts be primarily directed to first establish Bangladeshi domestic industries which, in turn, would drive the country’s S&T development initiatives out of their own necessity?

The paper summarizes the National Science and Technology Policy (NSTP) position which clearly points to the integration of S&T development considerations with the country’s economic development strategies. The question is: how can it be achieved? NSTP aims to transfer and utilize R&D results in the commercialization of products both in the public and private sectors. However, the National Council for Science and Technology (NCST), the apex body in charge of overseeing the implementation, Mahmud complains, has “rarely met during the last three decades”.

This should not come as a surprise because these deductive top-down approaches are disconnected and misguided in the first place. It should also not come as a surprise that the domestic production of value-added commodities requiring sophisticated scientific and technological knowledge is against the interests of the Bangladeshis who rule the country. The rulers are engaged in rent-seeking activities associated with the importation of these goods into the country. Mahmud vents his frustration with the comment: “Good intentions are of no use if they are not implemented”.

Even though Mahmud recognizes that the country’s R&D efforts are constrained because they “are not generally related to long-term development objectives”, he mistakenly places blame on brain-drain for “the shortage of competent scientists, engineers and skilled technicians” in the country. Brain-drain, in actuality, is not a cause, but an effect. As mentioned earlier, the ruling classes of Bangladesh rely, for their living, on the rent-seeking activities, connected with the import and trading of value-added commodities; so they prevent the establishment of domestic industries that could produce these value-added commodities.

The paper discusses the question of technology transfer in some detail. The blanket expectation placed upon so-called technology transfer from advanced countries or the expectation of importing S&T using external funding from donor countries is a misguided notion in the context of competitive free-market principles. Mahmud acknowledges difficulties involved in such endeavors and aptly calls for “endogenous leadership” and “determined political will” to achieve “technological self-reliance”.

It should be of no surprise to anyone that S&T capability building through externally funded projects have thus far proven elusive. The people of Bangladesh should also be aware that domestic technological base can only be created, as Mahmud points out, through the exercise of national political will and self-reliance. Foreign aid would allow import of high-ticket value-added items but not the import of high technology into a recipient country like Bangladesh.

The primary objective of externally funded projects is to create local demand of value-added goods that are directly or indirectly imported from the countries providing funding for these projects. The non-government organizations (NGOs) are also similarly engaged in promoting externally funded projects and programs and as such cannot undertake the domestic production of value-added commodities like durable, intermediate and capital goods. The industrially advanced countries of the world, which provide funding for the projects in the developing countries, (a) must secure the local market in the recipient country, (b) must protect their own industries in their homeland, and so (c) cannot allow emergence of competitor companies in the recipient country. As a result, it is not surprising that value-added local substitutes are not allowed in the externally funded projects.

Mahmud remarks that the Bangladeshi society is exposed to higher form of technology because of import of high-tech goods whose demand is created due to the efforts of the funding agencies, but such exposure “cannot help achieve the technological goals of the country”. The ideal position for the funding nations is to sell high technology goods to developing countries, but prevent developing countries themselves from developing high technology in-house.

In order to explain why technology transfer efforts have not worked so far in the country, the paper lists a number of reasons, one of which states that the entrepreneurs in the private sector do not understand the value of market assessment and thus fail to orient their product offerings in accordance with market demand. This is quite contrary to the truth. The private sector entrepreneurs, who have been really trying to carry out the production of, for example, machinery parts and components, heavy and light machineries, etc., are fully aware of market conditions, including its size, nature, direction,

movement, and so on. They, however, know that they have a losing battle on their hands because the successful domestic production of these potentially high-tech products is not in the best interest of the three Bangladeshi groups such as the politicians, civilian and army bureaucrats, and traders, who rule the country. The life styles of the three groups depend upon the rent and commission derivable from the import of these goods.

The paper summarizes the broad policy positions, such as state protectionism and subsidies that led the NICs of Asia to huge success. Mahmud’s analysis of why the same policies have not worked for Bangladesh is right on the mark. The protection and subsidies were not used in product development/enhancement or productivity improvements. Instead, these were turned into permanent sources of rent. Mahmud correctly observes, “In many cases productivity improvements were seen to be threatening to the status quo”. Systematic absorption and diffusion of foreign technology was never on the agenda to begin with.

The reviewer is in full agreement with Mahmud’s analysis which explains why the so-called appropriate technology may not be appropriate for a developing country like Bangladesh. There is no need to make a distinction between appropriate and non-appropriate (advanced?) technology, as applied to developing or developed countries alike. Mahmud is correct in identifying two most important aspects that relate to technology adoption in any country, developed or developing. One is the dynamism associated with technology implemented through market-driven product creation and the other is the consequential rise in productivity.

It means that no matter which type of technology is chosen, there must be provisions for continuous improvement, driven by competitive market forces, towards more sophisticated forms of technology, as well as towards continuous improvement in human productivity. Thus, when external funding or development agencies such as United States Agency for International Development (USAID) or Canadian International Development Agency (CIDA) or Swedish International Development Agency (SIDA) and so on, prescribe primitive indigenous technology for Bangladesh’s development projects, one should immediately

put it to Mahmud's test: does it represent "technological dead ends without any innate dynamism normally associated with technologies that help a country climb the ladder of productivity."

Concluding Remarks

The paper has presented solid evidence why the S&T development aspiration of Bangladesh has failed so far. In many instances proper policies were in place, but there was clear lack of implementation initiatives. Every nation, including the industrially advanced nations, has the right to protect its vital industries and preserve the marketability of its products anywhere in the world. As a result, it does not make sense for the developing nations to rely on externally funded projects to fulfill their own S&T development aspirations. It is the duty and responsibility of the leaders of each nation to create the scientific and technological base needed in the country through the establishment of the type of industries that requires the use of

higher form of scientific and technological knowledge.

S&T cannot be created and sustained in the country in the absence of relevant industries that can utilize this knowledge. The promotion of S&T in a society, lacking industries that require higher form of scientific and technological knowledge, encourages brain drain out of the country. Since Bangladesh already has rudimentary durable and capital goods industries on its soil, it should first and foremost stimulate the local demand of similar goods by (a) reducing taxes on raw materials, (b) allowing local entrepreneurs to have easy access to energy, land and capital and (c) increasing import taxes on these goods. With the stimulation of local demand of these goods, S&T will automatically take root in the country as a natural outcome.

Ashraf Ali, Bangladesh Development Initiative (BDI), Pennsylvania and Washington.
www.bdiusa.org.

Commentary

Shafiqur M. Rahman

In the article “Science and Technology Development in Bangladesh: Failure in Policy Implementation,” Dr. Iqbal Mahmud points out that considerable progress has been made in the agricultural sector in Bangladesh. This is not true of other sectors, particularly of *Science and Technology* (S&T). The growth in agriculture benefited from systematic and sustained investment by the government. However, the S&T sector, as pointed out in the article, has seen lofty pronouncements by the government, but little investment. In this environment, it is not surprising that Bangladesh lacks in this area compared to its neighbors and other developing countries. Improvement in ST requires good science education as its precursor. So the important question that needs to be addressed is: What can be done in the short and the long run to enhance science education?

In the short run, a variety of highly effective new teaching methods, which do not require any additional resources, can be implemented. Two of these are described below.

When computers found broad use in education, particularly with visualization of scientific data, the gap in learning by students between developed and developing countries widened further, because visualization enhances understanding, but computers were prohibitively expensive in the developing countries, and therefore out of reach of students. *There is currently a unique window of opportunity to level this field somewhat, and it comes from research on science education.* The education system in Bangladesh, and pretty much throughout the world, is based on the idea that students arrive as “empty vessels” and are gradually “filled up” with knowledge delivered by the teacher. Several surveys have shown that the retention of knowledge is extremely poor in this traditional mode of instruction. Based on research in science education, particularly about how students learn, several new methods have been developed which seem to be substantially more effective in retention of knowledge. The most well known among these is the “**Peer Instruction**”, (<http://mazur-www.harvard.edu/research/detailspage.php?ed=1&rowid=8>) developed by Prof. Eric Mazur of Harvard, in which students study the book themselves, and

classroom time is spent in considering several multiple choice questions. Students start by voting for whichever of the multiple choices they think is the correct answer for a problem, then by trying to convince each other why the answer they chose is the correct one. Then they vote again. The second time around, almost everyone ends up with the correct answer. In the process of the discussion, they learn from each other, and misconceptions are removed.

A second highly effective method is the **JITT** (Just In Time Teaching) (<http://134.68.135.1/jitt/what.html>). Using this method, students do pre-reading of the material, and take a very simple on-line quiz a day or so before the lecture. The teacher fine tunes the lecture based on the result of the quiz, emphasizing areas that students seemed to have difficulty with. This method finds its popularity also due to the fact that students have to read the material before the class, which invariably leads to easier understanding during the lecture and better classroom discussions. Teachers who are uncomfortable giving up traditional lectures find this method very appealing. It can easily be adapted to an environment where computers are not available for students to take online quizzes—answers could be handed in at the beginning of the class. Some material for JITT was made available by the author of this comment to Prof. Zafar Iqbal of Shah Jalal University in Bangladesh. The latter confirmed in a recent meeting that the method works.

In the short run, a pilot project that involves only a small number of teachers could be carried out to introduce some of these new teaching methods. Resources required for a workshop on this topic are minimal, and a private organization or agency might be willing to provide the necessary funding. This could then be disseminated to other teachers through additional workshops, with each of the original participants leading one of the new workshops. In the absence of funding, these ideas could be disseminated through mass media such as newspapers, as is currently done for examination material, and through TV.

Let us now consider the long-term possibilities. Given the enormity of the problems that any government in Bangladesh has to face, it is understandable that their top priority will always be to ensure adequate food production. With the agricultural sector doing reasonably well at this

time, it should be possible to convince an enlightened government to deploy a reasonable amount of resources to the S&T sector. How should these resources be optimally deployed? A highly effective way, as Professor Zafar Iqbal mentioned during a discussion, should be in teacher (re)training, because teachers have direct links to the students.

The education system in Bangladesh is based on rote memorization, which trains students very well to absorb facts for a short time and to reproduce them in examinations. Science, on the other hand, requires an inquiring mind with the ultimate goal of “creation” of new knowledge. As Dr. Mahmud mentions, “The spirit of inquiry, the degree of acceptance of the right to question and be questioned” are fundamental to the environment in which science thrives. The societal culture in Bangladesh, which also permeates the educational culture, is one of conformity, i.e. exactly the opposite of what is required for science. It is not surprising that many of our bright students going abroad do extremely well in examinations, but cannot sustain that momentum of being ahead of others when it comes to doing independent research. So how can teachers be retrained to do real science with their students, which will require that they become comfortable with “open ended questions”, i.e. questions whose answers are not unique and cannot be neatly packaged like the answers at the end of a textbook? It is not as difficult as it may sound. A simple experiment that involves growing a few plants from seeds in several paper cups, and allowing them to be in

the sunlight for varying lengths of time, can open a whole world of scientific enquiry involving *cause and effect*, *correlation*, and *statistical analysis* with answers that will be different for each student. *Teachers can be easily trained to work with students on such projects.* Clearly, long-term development of the science base of the country will require substantial investment in training those who will teach our students.

During a recent visit to Bangladesh, the author of this commentary was horrified to see the questions on “General Knowledge” which a relative was cramming for an admission test from a book. The question “How many gas fields are there in Bangladesh?” was immediately followed by a question on the number of sectors in each of those fields. The first question is interesting, but the second, especially because the number varies from field to field, was clearly a test of the ability to memorize. The long-term goal has to be to wean the nation away from rewarding rote memorization, and to channel that energy to develop thinking ability, because only the latter can provide the necessary ingredient for developing science and technology in an effective way.

Shafiqur M. Rahman
Professor of Physics
Allegheny College
Meadville, PA 16335
USA
srahman@allegheny.edu

WOMEN'S POLITICAL PARTICIPATION IN BANGLADESH AND INDIA: SYMBOLIC OR REAL?

Pranab Kumar Panday

Abstract

What is the present state of women's political participation at the local government level in Bangladesh and India? What factors led both governments to initiate several affirmative actions for the enhancement of women's participation? What factors impede their participation in the political arena? And what happens to women of both the countries once they participate in the local government bodies? This study seeks to answer these questions and is based mainly on secondary research. The available findings suggest that despite undertaking affirmative actions by both governments, women are still victimized by structural, religious and cultural impediments. The finding also suggests that once they make their way into the political process, they are not cordially accepted by their counterparts. Although few NGOs and women's organizations have been vocal in favor of women's equal rights, their initiatives remain inadequate. Another important finding is that women members cannot exert any influence in decision making at the local level. Once they ask for their legitimate rights, they are often victimized, assaulted, and harassed.

Introduction

Women's lives in South Asia are often affected by various socio-cultural and ethnic forces, a range of religious faiths, obscure legal frameworks, and complex economic and political forces. Despite diversities across countries, women of South Asia face similar conditions (Rustagi, 2004). Patriarchy characterizes South Asian countries (Caldwell, 1982) where women are dominated by a kin-ordered social structure (Mathema, 1998). They have low status, little or no access to property and land (Bardhan, 1986) and get little recognition for their largely unpaid home-based labor (Rustagi, 2004).

Socio-cultural practices based on strong patriarchal traditions have served to curtail mobility of women in this region. Disproportionate involvement in the labor market and restrictive socio-cultural influences on education, nutrition, health and political participation are evident among women in most South Asian countries, although it is not always possible to measure gender discrimination in all spheres (Rustagi, 2004). The present study is one of the few studies that attempt to link the gender issue with that of local governance. It is also a comparative study of two neighboring countries that are similar and yet reflect significant differences. Since our main objective is to highlight the issue of political participation of women in Bangladesh and India, other aspects of gender inequalities will not be taken into consideration in this paper.

While attempting to explore the dimension of

women's participation in the local governance in Bangladesh and India, special emphasis will be given to the following components: (a) women and local governance in South Asia (b) determinants of women's participation and their role in Bangladesh and India (c) challenges that women face in regards to their participation in local governance in both countries (d) women's ability to participate fully in the local government's decision making bodies and (e) ways to overcome persistent barriers to women's participation.

Gender and Democracy

'Democracy,' a much debated issue in modern times, has become an objective to which individuals and nations around the world aspire. Democracy generally falls within the traditional definition of politics which includes the domination of male members in the public sphere. Due to these traditional orientations, it is widely argued that democracy is not women friendly (Karim, 1998). Despite these limitations, there has been increasing popularity of the concept and its practice in recent times. In this context, an important question draws the attention of the academics and practitioners: Why should gender be interlinked with democracy? Some important arguments in this regard have been put forward by Karim (1998).

First, broadly defined, 'politics' includes every person's concerns. From this point of view, women's political right is an integral part of human rights which in turn is a fundamental aspect of the

democratic framework. The second argument is that while formulating any decision or carrying out any strategy in democracy, it is essential to take into account the views of all involved groups. In other words, it can be said that opinions and perceptions of both men and women must be included. This argument is also important to justify the usefulness of bringing minorities in the decision making processes. The final and strongest contributing factor is that half of the total population in today's world are women. That is why it is unreasonable to treat women as minority. So, while making any policy regarding citizens' lives, the policy makers should bear in mind that their policy will no longer be credible until and unless they ensure equal participation of both men and women in the policy processes.

Nowadays it is accepted among concerned parties that an effective strong local government system is one of the essential preconditions for ensuring good governance. And democracy is one of the important features of good governance. It is also generally agreed that democracy is a key foundation on which the edifice of developed local government has to be built. A sound local government system can initiate and strengthen the local democratic process by electing representatives to uphold democratic values and to practice democratic processes and procedures for development. (Shamim and Nasreen, 2002). So it can be said that equal participation of women and men in every aspect of life is required to have democracy and sustainable development.

Women and Local governance in South Asia

South Asian countries have become a part of the process of globalization that has led to a discourse on development, with different perspectives. This development discourse puts gender and governance as a critical area of concern at all decision-making levels. In this regard, most South Asian countries have enacted laws for better governance and fair representation of gender in the local government.

Certain common features like centralized government, socio-economic inequalities based on class, gender and caste, and nationalistic divisive claims on grounds of ethnicity have characterized South Asian Countries. For more than 50 years, India and Sri Lanka have been democratic countries, but Pakistan and Bangladesh have fluctuated between democracy, militarism and autocracy. Nepal is in turmoil; it has traversed from democracy to absolute

monarchy and back to democracy and is now reverting to absolute monarchy. (Kabir, 2003).

Generally, in South Asia, the formal political system is dominated by males, but the degree of domination varies from country to country and region to region. Signs of domination are evident when women are assigned to soft portfolios 'appropriate' for women's concerns, even when they become a part of the formal political process as members of elite political groups. Usually, women in the entire Indian Subcontinent are viewed with distrust if they interact outside their designated areas. They are generally viewed as weak members who should be protected and are expected to remain outside politics, as it is a 'dirty game' (Kabir, 2003).

A significant characteristic of South Asian politics is that the highest position in the government of several South Asian Countries has been occupied by women; classic examples are Indira Gandhi and Sonia Gandhi in India, Sheikh Hasina and Khakeda Zia in Bangladesh, Benazir Bhutto in Pakistan and Sirimavo Bandaranaike and Chandrika Kumaratunga in Sri Lanka. Even though these women occupied the highest position in government, the condition of women at large is very different. The vast majority of South Asian women are illiterate, in poor health, invisible in the system of national accounts, and suffer from legal, political, economic and social discrimination in all walks of life. Another noticeable fact is that they have the lowest rates of participation in their governance structures as compared to many developed nations (Mahbub Ul Haq, Human Development Centre, 2000).

The Fourth World Conference on women, held in Beijing, advocated in favor of ensuring adequate representation of women in all decision-making bodies (Beijing Platform for Action, 1995). It was suggested that in order to voice the concerns of the society in equal terms, it was necessary to ensure a 'logical balance' of men and women in public life. Participation, accountability, predictability and transparency are the basic characteristics of good governance. In these contexts, good governance generally calls for gender balance in political decision making. Very often, it is argued that the overall decision making process can be enriched if women's insights and values of governance are reflected in these processes. It has been also established that women at the local level are more responsive to community issues (Shamim and Kumari, 2002).

Although there are rural, urban, and regional variations with regards to women's opportunities and access to resources in South Asia, they operate within fairly harsh manifestations of patriarchal structures and attitudes throughout the region that diminish women's compensated work and encourage her role as wife and mother. This attitude pervades policy making bodies. As a result, development policies, especially budgetary allocation for women's programs, remain insufficient, reflecting the priority that is given to economic development rather than the social sectors (Villareal, 1998).

Gender is a major factor defining social roles, family responsibilities, and power relationships within the family. In South Asian Societies, men are the principal wage earners and the main decision makers in the family. A careful analysis of social norms and behavior related to gender, power relationships and sexuality reveals that they are embedded in the dominant social constructs of masculinity and the social control of women's sexuality (Villareal 1998, UNFPA 2000). Patriarchal nature of the society and state permeates into the policies for women's integration in various aspects of the socio-political institutions. And this has adversely affected women's participation in the political system and hindered their incorporation into mainstream politics and the economy of the country (Shame and Noreen, 2002). Women are also disadvantaged with regard to health and health care facilities (Fikree and Pasha, 2006) and their sexual roles are meant to be private and controlled, rather than public and expressive (Khan, 2002).

Many South Asian governments have amended their laws for fair representation of gender in the local government institutions because organizations at the grassroots level allow people to contribute significantly to the governance of their communities. For women, successful grassroots experience has meant an opportunity to form a coherent voice, to be heard and to make a difference in their communities. Across South Asia, the experience of women in local governance has been varied, with some being more successful than others in attaining greater women's participation.

Current State of Women's Political Participation in Bangladesh and India

Women's representation in the South Asian region is at two levels: in national and provincial/state legislatures and in local governments. In the former

they can play a role as law- and policy-makers and in the latter in development-related implementation. The experience in different countries in the region reveals that, collectively, the number of women in legislatures has been lower than 9 percent over the last five years. This was despite the 1995 Beijing Platform for Action's goal of adequate representation of women in all decision making bodies and the recommendation of creating a "critical mass" and "gender balance" in political decision making. In this paper our main concern is to highlight the state of women's participation in local governance in Bangladesh and India.¹ We restrict our discussion of this matter to two countries only.

India

The scope for women's participation in politics in India is wider due to its federal nature.² Women have also become increasingly active in informal politics also. The historic opening for women in India came in 1993 with the enactment of the 73rd amendment (*Panchayati Raj*) and 74th amendment (the Municipalities Act for urban local government) to the Constitution of India. These amendments came against the backdrop of the campaigns of the women's movement in India that gained momentum in the eighties--defining the movement's identity, finding a base in "issues being articulated by poor women at the grassroots" and their absorption into the "movement's range of concerns" (Mazumder and Agnihorti, 1999). Earlier in 1975 the Committee on the Status of Women had recommended the establishment of statutory women's *panchayats* at the local level but the recommendations had been shelved (Mumtaz, 2005).

The amendments provided for not less than one third membership (33 percent) to women in the three tier system of *Panchayati Raj*⁵ in rural areas. One-third of the prescribed women's seats are for women of Scheduled Castes and Scheduled Tribes. At least one-third of the office bearers are also reserved for women. The term of the *panchayats*, their re-election and the conditions for their suspension were also laid out in the amendments. These were followed by states enacting conformity legislations by 1996, with some variations in details (Gala, 1996). For instance, the Orissa government made it mandatory for the vice-chairperson to be a woman if the chairperson is a man. Rajasthan, Haryana and Orissa debarred candidates with two children to contest elections and some have special provisions for conflict resolution at all levels (Mumtaz, 2005).

The *Panchayati Raj* brought more than one million women as members and chairpersons of local bodies. However the performance and election of women in different states varies: Madhya Pradesh and Himachal Pradesh elected 38 percent women in the elections of 1996, Punjab 29.6 percent and Karnataka a little over 43 percent (Mohanty, 1999).

While the Acts *per se* do not provide for all-women *panchayats*, their subsequent emergence has been an interesting development. It needs to be pointed out that as early as 1989 nine villages in the western state of Maharashtra had elected all-women *gram panchayats*, reportedly an outcome of the campaign of an independent farmers' organization, Shetkari Sanghatana. West Bengal got its all women *gram panchayat* in May 1993 under the Left Front Government (Gala, 1996). Earlier, an all woman *panchayat* was elected in Andhra Pradesh in the seventies and another in the eighties (Kaushik, 2000). One other reason for all women *panchayats* was that higher caste men did not want to work under a lower caste woman (Mumtaz, 2005).

Bangladesh

The scope for women's participation in politics in Bangladesh is not as wide as in India due to its unitary nature.⁴ Since independence in 1971, the local government system⁵ has been central to policy makers' concerns. With a view to securing a minimum representation of women at local level government bodies, in 1976, the government promulgated the Local Government Ordinance and introduced a three-tier local government system. In this Ordinance the structure of the local government system underwent changes and the provision was made to select two women members in the union council (Ahmed, 2001). For the first time women were considered to be included in the local government. With the passage of time, every government tried to incorporate more women in local government bodies. In 1983, changes were brought in the structure of the union parishad, promulgating the local government (Union Parishad) ordinance. The earlier system (1976) remain unchanged; one chairman and 9 members were to be elected directly, 3 female members, 1 from each ward had been added in the new ordinance. In 1993, Local Government (Union Parishad) Act (Amendment) was passed in the Parliament to secure the minimum representation of women in local government. According to this act, provision was made that each union parishad would be divided into nine wards. Moreover, three seats

were reserved for women; accordingly, they were elected by the chairman and members of the Union Parishad rather than directly elected by the voters (Ahmed, 2001).

The Local Government (Union Parishad) Second amendment Act, 1997 is a milestone in the history of women's participation in Bangladesh. In this act, provision was made for three reserved seats for women in each Union Parishad. In addition, they would be elected by direct election based on universal adult franchise. This was a major initiative taken by the government of Bangladesh for ensuring women's participation in political decision making (Sultana, 2000).

The union council is made up of thirteen members including the Chairman and three women. Each woman however represents three wards and is elected by the combined voters of these wards, thus serving three times the number of constituents than her male counterparts. The Chairman is elected by the entire union council. Various functions of the union council are executed through 13 standing committees and women are to head one third of them, with the mandate to head the committees on women's and children's welfare, culture and sports; however, in reality women are often excluded from the committees (Cited in Mumtaz, 2005).

Getting the right to participate in governance through reserved seats was the proverbial first step for women in Bangladesh. In the Union Parishad election of 2003, 39,419 female candidates contested 12,669 reserved women's seats. On an average, 3.1 women contested one seat. Although the rate of participation of women candidates in the reserve seats is quite satisfactory, the participation rate of women in general seats and for the post of chairmanship is quite low. Of the 21,376 candidates who contested the chairman's posts, 21,144 were male and 617 female. On the other hand, 137,909 candidates competed for general member posts; among them 137,292 were male and 617 were female (Bangladesh Election Commission, visit: www.bd-ec.org/election.php3).

Determinants of Women's Political Participation In Both Countries

In the preceding section, an effort was made to highlight the current state of women's participation in the local governance in Bangladesh and India. Due to initiation of several amendments in the Constitution by both governments to increase women's

participation in the political process, the presence of women in local governments has increased considerably. Now the important question that needs to be answered is this: What are the determinants of women's participation in both the countries? In the following section an effort is made to identify those determinants and analyze their role in explaining women's participation in both countries.

Non Governmental Organizations (NGOs)

Both governments have been influenced to a large extent by the ever-growing contribution of Non Governmental Organizations (NGOs) in furthering the cause of equal rights of women in every sphere in life. Over the last few decades in India and last few years in Bangladesh, along with advocating for women's equal rights, NGOs are conducting several training programs for women.

In India, NGOs have been actively involved in training over a half million Panchayat members in the state, a majority of whom are poor, uneducated and helpless. It is a complex task. NGOs have played a key role in generating consciousness and mobilizing the people (Sharan, 1998). While there are a large number of NGOs in India, working to help women win confidence and gain more knowledge about their role as Panchayat members, their capacity via training varies greatly (Matland, 1998(b)). One successful example is that of the Confederation of Voluntary Organizations (COVA), a network of 750 organizations in Hyderabad, India. COVA works for communal harmony through community empowerment. It began its intervention with the objective of establishing the legitimacy of women political representatives to address the concern that women's reserved seats had been captured by male politicians, who in fact performed the duties of elected women (Mukhopadhyay, 2005).

The case of Bangladesh is slightly different from India. Along with advocating equal rights for women, sometimes these NGOs play a direct role in politics. Some NGOs through their umbrella organization, Association of Development Agencies of Bangladesh (ADAB),⁶ indeed played a proactive role in national politics during the mass movement⁷ which emerged against the Khaleda Zia regime in the mid 1990s. In the election of 1996, ADAB coordinated a Democracy Awareness Education Program through which 15,000 trainers ran awareness raising workshop across the country, contributing to an impressive voter turnout of 74% (Ashman, 1997).

These activities inspired both men and women to involve themselves in electoral politics, especially women members who gained immense knowledge from these programs. Another example is the efforts of Gono Shahajjo Sangstha (GSS).⁸ While encouraging its landless group members as candidates in local union parishad election in Nilphamari⁹ it was brutally confronted by local landlords, who burnt the NGO's schools, attacked staff and members and conducted a house to house search to seize books and publications (Hashemi, 1995). All these activities of NGOs build awareness among its women members in regards to their involvement in the political process. They also create immense pressure on the government to make necessary changes in their policies regarding women's participation.

International Politics

Recent shifts in international politics in favor of equality of women in all spheres of human life also partially account for the changes made by the two governments in the national, as well as local levels. The government of Bangladesh approved both the Programme of Action of the international conference on Population and Development (1994) and the Beijing Platform for Action (PFA) without any reservation (Karim, 2000). Apart from these conferences, various donor agencies like World Bank, International Monetary Fund (IMF) and others have taken the issue of gender governance as their priority objectives. For instance, although the World Bank is mainly an economic institution that has to maintain political impartiality, the issue that 'good governance is essential for development' is gaining importance within it. Studies by World Bank have confirmed that 1) worldwide women are under-represented in parliaments: the best performing region has less than 20% while the worst performing region has less than 5% representatives in their parliaments; 2) governments are less corrupt where women and men have more equal rights and more equal participation. Although this finding is very controversial as regards causality, it is nevertheless a positive finding (Mukhopadhyay, 2003). Based on these findings, World Bank ensures women's equal participation in the political process within its aid recipient's countries. This might have had an effect on the government of Bangladesh in regards to bringing necessary changes in their policies towards women.

This factor may not have any direct effect on the Government of India as the economic base of India is

much stronger; thus, they are not dependent on several donor agencies. To some extent, however, the government of India responds firmly with the slogans of the international communities.

Women's Organizations

Women's own agencies which are fighting to ensure equal social and political rights for women, have been important factors that led both the governments of India and Bangladesh to bring about changes in policies regarding women's participation in politics. The experience in India and Bangladesh demonstrates that women's activism gained them the space that they now have and which they also have to defend and protect. In India, the debates around women's seats were carried forward into the post independence period. Women members of the 1949 Constituent Assembly opposed special concessions for women and hence reserved seats were not considered in the Constitution. Similarly, the Committee on the Status of Women in India rejected the idea of women's reserved seats in 1975 (there was a dissenting note on the issue by two members, activist/academics Vina Mazumder and Lotika Sarker who saw reservations as a necessary affirmative action for women). However, the Committee did make a strong recommendation for institutionalization of women's participation in local government through special quotas (Mumtaz, 2005). If we look at the role of women's agencies, there would be thousands of examples. The emergence of a countrywide women's movement on a mass scale in 1979-80 was sparked by a case of police rape--a common but by no means unique form of police brutality. The massive demonstrations and agitations by women, which followed the Supreme Court acquittal of a policeman who had raped a young woman, can be seen as a crucial element in the human and civil rights movement to protect citizens from arbitrary violence of state functionaries. Many of the women's organizations formed in the course of that campaign survived and grew subsequently, extending their concerns to various other forms of violence against women as well as more general social control over and discrimination against women (Hensman, 1996).

In Bangladesh, towards the end of 2001, when the provision of reservation of 30 seats in the National Parliaments lapsed, the movement by several women organizations mounted a concerted effort to mobilize opinion and create the necessary political will to provide for a quota system that reflected their stand.

Before the impending dissolution of Parliament in 2001, some 20 women's groups mobilized by Mohila Parishad (Women's Council--the largest movement oriented women's organization) lobbied the government, political parties and parliamentarians. Women activists carried on street activities, formed human chains, and staged rallies and symbolic protests advocating increasing the number of reserved seats in the Parliament, as well as introducing the system of direct election for women in those seats. However, this heightened level of advocacy failed to have enough impact on the Government of Bangladesh (Chowdhury, 2002). Although the government increased the number of reserved seats from 30 to 45, the system of election remained the same. When the government passed the bill for reservation of 45 seats for women in the parliament, the women's agencies went to court challenging the acts of the government, especially the provision of indirect election, although the Court had rejected their challenge. Along with advocating women's equal rights, these women's organizations always remained active to organize various training programs through which they can train women in leadership. For instance, Bangladesh Mahila Parishad (BMP), a mass-based organization was established in 1970. Committed to a society based on gender equality, democracy and peace, it has played a key role in promoting women's formal participation and has worked on training programs for women political representatives. Identifying the latter's main problem as isolation and hostility and disregard from male colleagues, BMP decided to intervene in three constituencies to address these problems. The BMP's strategy was to develop support groups for three women representatives--one from an urban council and two from the union parishad. Each support group was made up of 15 women from the representatives' constituency and included BMP members. The members were trained by BMP to enable them to provide support to the elected representative. They organized constituency meetings, built alliances with influential political leaders and linked the representatives with government officials. They also built the capacity of elected women and organized joint training for women and male elected members of the councils. The result was that elected women attended council meetings and questioned procedures, thus developing transparency; became more active and succeeded in getting development projects for their areas; took up gender specific issue; and set up an autonomous women's cell (Mukhopadyay and Meer, 2004). Thus, women's organizations not only created pressure on the

government to initiate policy in favor of ensuring equal participation, but also organized several training programs for women members to help them realize what is good for them, what their rights are and what they should do.

State

The different courses and political development processes that took root in both the countries have determined the nature of state policies. India has institutionalized a democratic system, although with aberrations of emergency rule in the country. Bangladesh has moved from Parliamentary to military rule to the presidential system, and sought integration into the regional and global economy. The state is however similarly seen in both countries as the agent for socio-political transformation. Given the privileged classes and groups' inherited political power, any opportunity that women obtained were through the benevolence of the state (Mumtaz, 2005). The turmoil that accompanied independence, in case of India, opened spaces for women and legitimized their participation at the public level (Mumtaz, 2005). It took final shape when the Government of India passed the 73rd and 74th amendments of the Constitution, ensuring 33% reservation of seats for women in the local level.

The emerging democracy of Bangladesh began its drive in the end of 1990 with the overthrow of autocratic rule by a mass movement. Since then democratization of local government units has become a priority for the government. That is why in 1993 the Local Government Ordinance, 1983 was amended to recognize the UP wards from existing three to nine new wards. Moreover, by getting rid of the nomination system of women members, the amendment provided for indirect election of three women members- by the chairman and members of the respective UPs. Again, in 1997, by the amendment of the ordinance, direct election for women members was introduced. Therefore, the changes in UP structure have been partially accounted for by the democratic transition in the country.

Constitution

The Constitution plays a vital role for ensuring women's political participation in both countries. The Indian Constitution has been committed to introducing socio-economic and political transformation. The initiatives to empower women

and the marginalized sections are reflections of the democratic spirit of the Indian Constitution and can be gleaned from a number of amendments in these fields, especially, the 73rd and 74th Constitutional Amendment Acts that provide for women's entry into the political sphere (Shamim and Kumari, 2002).

Like the Indian Constitution, the Constitution of Bangladesh also provides for equality of men and women. There is no legal barrier to women contesting or voting for any elective office, including that of the head of the state. Article 9 of the Constitution promotes the special representation of women in local government (Constitution of the People's Republic of Bangladesh, 1972; Shamim and Kumar, 2002).

Political Parities

In recent times, opposition political parties have been a powerful engine for influencing the government to initiate changes for increasing women's participation. The party in power all too often has strong incentives to evade accountability, but opposition parties have their own incentives to uncover wrongdoings of the government and publicly hound incumbents of their misdeeds. In the case of India, over the decades, political parties played a crucial role in furthering the issue of women's equal participation. If we look at the formation of political parties in India, we will find a number of women political leaders¹⁰ in every political party. Most of the political parties in India are committed towards the betterment of women. Another important factor is that in India, local government election is conducted on party basis. In this regard, political parties play an important role from candidate selection to election.

But, the case of Bangladesh is quite different: due to political instability, opposition parties always remain busy criticizing the government. They have hardly any time to raise their voices or create pressure on the government to initiate affirmative changes in regards to women. But, there are some leftist political parties who are more vocal on these issues, but they have no representation in parliament. As a result, their voices are not taken into consideration by the government. Another factor is that local government election in Bangladesh is not conducted on a party basis. That is why political parties show little or no interest in the process of women's participation at the local level. Moreover, both the leading political parties in Bangladesh are headed by women chairperson, but it is a matter of regret that the position of women in

general remains discouraging¹¹

Civil Society

Civil society is usually defined as organizational activity between the individual (or the family) and the state. Its democratic roles are to advocate for constituents, to act as watchdog over the state, and to support political competition generally (Hansen, 1996, cited in Blair, 2000). According to USAID and several donor agencies, civil society is essential for democratic local government (Blair, 2000). To ensure democratic local government (DLG), it is essential to ensure equal participation of women in the decision making process. In this context, civil society plays a strong role to ensure women's participation as well as ensure DLG. India is the most startling case because DLG has been in place there the longest. One would assume that civil society has at least gotten off to a good start at the national and state (and to some extent the district) levels, where organizations of women, environmentalists, professionals, farmers, and others have occupied a prominent role in the political landscape for some time.

However, Civil Society Organizations (CSO) in Bangladesh are different from those of India. Before 1990, there were hardly any CSOs in Bangladesh. After the restoration of Democracy in 1991, several of them have been in operation. But, these organizations have not been successful in furthering women's issue because of two reasons: An inadequate number of civil society organizations that deals with women's issue and the partisan characteristics of these organizations

The CSOs are clearly divided in two political streams. One allied to Bangladesh Awami League (AL) and other to Bangladesh Nationalist Party (BNP). That is why these organizations failed to capture the confidence of the general public, as well as government.

Media

Media plays an important role in bringing about changes in the society. The messages that are played and replayed through media go a long way in influencing the mindsets of the reader, audience and the viewer. This has resulted in the implementation of gender-sensitizing projects in various sectors within South Asia. In recent times, the media has played a crucial role for furthering women's issues. Actually,

the media's role is twofold. It brings women's issue to the government's arena on the one hand. On the other, it informs the general mass about the government's decision on a particular issue. The media highlights the issues of women's equal rights and demands government decisions in this regard. But, the media in Bangladesh until 1990 was totally controlled by the government. After, 1991, several private TV and radio channels emerged. The emerging electronic media in the country has brought about a striking change: A dynamic presence of female faces on the screen competing with their male colleagues. News channels now have more, female reporters, if not an equal number of male and female reporters. The electronic media, therefore, reflects a new scenario: a phenomenon of gender empowerment reflected in the presence of women journalists who occupy important roles. These channels are highlighting gender issues to a great extent. They broadcast different programs on women and present women leaders in front of the audiences with an intention of increasing the level of awareness of the general women. Along with the broadcast media, there are more than 170 daily newspapers published from various corners of Bangladesh. The situation in India is much better than Bangladesh as both print and broadcast media are free from government control. These newspapers and broadcast media, build public opinion which compels the government to accept changes.

Various international events like Women's Day, etc., are also highlighted in the media. The entire perspective could have been different if more women were involved in the decision-making panels, drawing attention of the policymakers to the praxis that women's empowerment is strongly connected with development issues.

Challenges to Women's Participation

In the above section, an effort was made to analyze several determinants of women's participation in Bangladesh and India and to indicate that women's participation in local governance in both countries is much lower than their male counterparts. The question may be raised: why is this so? Despite several efforts by the governments to increase participation of women in the process of local governance there are several challenges that women face while participating in political process. This section explores these challenges women face in both countries.

Educational Backwardness and Lack of Economic Resources

Education is perhaps the strongest factor that enables women to control their own future. Education helps women to be knowledgeable, skilled and self-confident to participate effectively in the ongoing developmental process of the country. (Villaluz, 2000). It creates awareness among women. However, it is unfortunate that the world's largest numbers of illiterate women are in India. According to the 2001 census, there is rampant illiteracy among women--around 46 percent as against 24 percent among men. Among scheduled castes and scheduled tribes, women's illiteracy is as high as 76 per cent and 81 percent (Mohon et.al, 2003). The case of Bangladesh is similar. According to Human Development in South Asia, 2003, the illiteracy rate is about 38 percent. But even beyond basic illiteracy, information about political process--for example, information about policies and voting system--is often difficult for women to obtain (Kabir, 2003). Women of both countries are not conscious about their rights. Unequal access to information limits women from recognizing and enjoying their rights to participate in political and social networks. That is why they are not interested in participating in political activities (Vijaylakshmi 2002, cited in Mukhopdhyay, 2005). Moreover, women in both countries are mostly concentrated in the informal economy, the subsistence sector, where many are engaged in low wage or unpaid, low skilled or unskilled labor. Much of their work remains invisible, unrecognized and devaluated and is therefore unprotected by laws and legislation. The incomes they earn, however meager, are still seen by them and their families as a contribution. Therefore the expenses for political participation such as election campaigns, and expenditures required to attend meetings and visit and interact with government officials, become an additional burden that women cannot afford, thus impeding their full participation. The following example will substantiate to what extent literacy has a strong impact on women's capacity to perform in political institutions:

“Manavva from Beldadi village, Gadag Taluk, Karnataka State of India, was elected to the position of Gram Panchayati (GP) president, which was reserved for Scheduled Tribe women. Because she was aware and articulate, her family encouraged her to stand for elections. The secretary of GP

appointed by the Government was an upper caste urban woman, who gave Mannave papers and ledgers to sign without explaining to her its content. Manavva was unaware that the secretary was appropriating funds. In time, Manavva became suspicious and reported the secretary's actions, which were investigated and resulted in the secretary's replacement. If Manavva were literate she would probably have been able to stop the secretary at an early stage” (Narasimhan, 1998; cited in Mohan 2003).

Mobility

Cultural norms operate both as a restriction on a woman's mobility as well as an impediment for women's participation in the public sphere in both Bangladesh and India. These cultural norms are perpetuated and sustained by powerful institutions of family, caste and religion. The location of polling booths and their relative distances from their homes and workplace often deter women from exercising their right as voters. The demands of contestants' right from filling nominations to canvassing for elections, requires them to be mobile. The inconvenient timings, distance and the lack of escort impede female representatives' full participation. Along with these problems, the family circumstances of women members is also an impediment to their mobility. Mokhopadhyay (2003) pointed out in his studies that, “in Bangladesh, as one husband said, this is a Muslim country; she (a woman member) is a woman, so she cannot go out in the evening. He (the husband) saw his wife's responsibility as caring for the children.” Thus, it becomes very difficult for a woman to involve herself in non-household activities.

In the case of local government in India, the situation is more severe than Bangladesh. Along with several social, religious and economic constraints, women face violence, which has increased after the introduction of the 73rd Constitutional Amendment Act in India. Violence in the form of beating up those women and their family members who contest elections and sexual harassment in public are more frequent during elections. In protest of this violence, women remain silent (Shamim and Kumari, 2002). One may ask as to why the extent of violence to women and their family members has increased in India after the introduction of the 73rd Amendment. One possible explanation may be that groups of

people with vested interest use violence as a means to discourage those women who wish to take part in the local government elections.

Structural Deficiencies

In Bangladesh, women representatives are disadvantaged by structural constraints arising from the way in which quotas for women are incorporated within the electoral system. For instance, the union parishad (the local government institution in Bangladesh) is made up of nine wards and the electorate in each of these wards elects a general member--usually a man, although women are not barred as candidates to general seats. The quotas for women were instituted by providing three additional seats within each union parishad, and potential women representatives to these seats are elected by and are responsible for three wards. This means that women candidates have to canvass across and be responsible for an area three times the size of the area covered by a general (male) member. Women are further disadvantaged by resource constraints because they receive the same budgetary and other resources received by a general member, even though they must cover a wider area. There is also role confusion, as the role of the one woman representative who operates in a constituency, which also has three general members, is not clear (Mukhopadhyay & Meer, 2004, cited Mukhopadhyay, 2005).

In Bangladesh, even though the female chairpersons and members have gained confidence in their ability to undertake administrative jobs, the discriminatory attitude of their male counterparts has been the main "stumbling block". Women Union Parishad members have no fixed work or duties and they are allocated fewer resources and given less formal legal powers than male colleagues. According to the Local Government Ordinance 1997, elected women Union Parishad members will act as chairperson in at least three of 12 standing committees of the union parishad. But in reality, it is found that in many of the Union Parishads the standing committees have not yet been formed. Moreover, where they are formed, the women members have no responsibilities despite their inclusion in the committees (Shamim 1999). Women members are not even empowered to hand out birth certificates which is a basic function of commissioners. Later on, with the assistance from Mahila Parishad and Ain O Salish Kendra, these women went to the court and won their right. Despite rhetoric and some formal measures, the state delegitimizes women's authority at the outset, thereby

handicapping their ability to perform in their political role.

In India where there is 33% reservation for women at all levels of the local government institutions (three-tier system), the seats reserved for women rotate in every election. Thus a ward reserved for all-female competition becomes a general ward (in which women and men compete) in the next election. As a result political parties simply do not take women's candidacy seriously, nor do they invest in the elected woman candidate knowing very well that in the next round of elections these women would be of no use to their electoral prospects. The selection of female candidates by parties for reserved seats is, thus, to a large extent determined by the calculation as to which women are the most 'useful' either because they are related to powerful men or because they can be easily bypassed in everyday political decision making (Mukhopadhyay, 2005). Goetz (2004) and Beall (2004) noted that in many countries where affirmative action for women exist in local government elections, these measures were introduced as an afterthought thus detracting (pessimistic) from the credibility(reliability) and legitimacy of women as political actors (Mukhopadhyay, 2005).

Women of both the countries also suffer from their gender identity. In a highly stratified and gender-based society, women members are not viewed separately from their identity as 'women.' It is evident that women local representatives do not have specific responsibilities and their opinions are not heard given the negative attitudes of male colleagues (Shamim and Nasreen, 2002). These factors give rise to insecurity among the women members. Another important factor that deserves special mention is the economic structure of the society. In both countries, the economic structure of the society is mostly dominated by male. If women earn any amount, they do not have the freedom to spend their money. Majority of the women in the local level in both the countries are engaged in household work rather than in income generating activities. Besides, the amount of wages that these women members are paid in Bangladesh is very low (only BDT 350 TK which is equivalent to US\$5). These low earnings cannot bring any noticeable change in the lifestyles of women, which also discourages them from taking part in local level politics.

Religion

Religion also plays a very crucial role in keeping

women at home rather than going outside and participating in political decision process in both the countries. The only point of difference is the type of religion that impedes women's participation. According to the 1991 census, Bangladesh is close to 90 percent Muslim and their religion is Islam.¹² Islam represents a strong apology for patriarchy and is explicit about the sexual division of labor and responsibility and in effect, sanctifies male dominance. Restriction has also been imposed by religion on the movement of women outside their house. Women are instructed to use 'purdha'¹³ when they are outside their home. Once habituated to restricting themselves within 'purdha' they are likely to lose any interest in political activities.

The expansion of fundamentalism has introduced new forms of oppression and violence against women, in Bangladesh. Increasing cases of violence against women meted out via *fatwa*¹⁴ and *mullahs*¹⁵ in the countryside are being reported. Besides, there has been a rising trend in religious fundamentalism which has gradually pushed its presence into the mainstream political space. A number of actions on the part of successive governments have led to its growth (Shamim and Nasreen, 2002 and Shehabuddin, 1999).¹⁶

Unlike Bangladesh the majority of the Indian population is Hindu, although there is a considerable number of Muslims in India. The Hindus by religion suffer from class and caste system. Upper class Hindus always dominate the lower class Hindus and they generally do not allow lower caste people to come forward and go for elections in political institutions, although there are reservations for tribal people in different levels. But the problem lies in the fact that it has been rooted in the mentality of the millions, and it will need decades to change such a mental make-up.

Participation of Women in Political Decision Making: Symbolic or Real?

Now an important questions needs to be addressed: Does the reservation of seats for women in the local government institutions in both the countries ensure their active participation in the political decision making process? The situation is perhaps not satisfactory as male members are more dominant and use their patronage networks to function as elected representatives because their role in the public world of politics is taken for granted. However, this is not so for women and herein lies the gender dimension of

political representation. There is no getting away from the fact that affirmative action taken by various government has given rise to what has been termed as de facto politics (Vijaylakshmi 2002, cited in Mukhopadhyay, 2005).

One may wonder how the researchers measure whether the participation of women member is symbolic or real? In reply, I would argue for chosen indicators and try to measure their status based on field data. As the study is basically based on secondary materials, I will try to measure the extent of their participation by analyzing their involvement in the decision making process and from the attitude of the male members. Affirmative action does ensure that more women will come into politics, but it does not ensure that elected women will be seen as legitimate political actors. This situation is obvious in case of women in the Union Parishad as well as women members in the Panchayati Raj. But, it does not mean that all women in all circumstances are subsumed in de facto politics¹⁷. There are few women in local government bodies in both countries who have been effective in discharging their duties and responsibilities. But their number is so few that it does not represent the women community. One may query whether women who enter politics through patronage can make a difference once they are in a position to do so? It is important to clarify that entry into the political process and performance are different things. In most cases, women use patronage to get into the political process, but it does not help them while discharging their duties and responsibilities. At the same time it is not fair to say that patronage does not help women. If we go into more detail, we can find some cases where women having strong linkage with political parties are dominating the process of decision making. But their number is also too few to set as an example as these women work under the patriarchal societal structure too.

Several studies were undertaken on women's participation in the political process in order to assess their role in decision making. According to the Asian Development Bank (ADB, 2004) more than 70% of women councilors interviewed in Bangladesh were not aware of their rights and responsibilities as representatives; an even higher percentage--more than 80%--expressed their lack of confidence in their ability to conduct meetings (Mukhopadhyay, 2005). Actually a patriarchal society offers little or no space for women's authority and agency. As a result women become handicapped and play a symbolic

role in decision making. Goetz (2004) offers the argument that decentralization tends to bolster and ingrain existing traditional institutions and local elites. These institutions tend to be deeply patriarchal, offering little or no space for women's authority and agency. In other words, society does not allow women to occupy leadership roles in the process of decision making, or play a positive role, or be vocal anywhere. We can quote a speech of an ex-parliament Member of Bangladesh, Tasnima Hossain, who is the wife of Anwar Hossain Munju¹⁸. In her address in a round table meeting in Dhaka on 'Role of Civil Society and New Media to Prevent Violence against Women' she said:

'I was not treated as a colleague by other Parliament members in the Parliament. Rather I was mostly treated as 'bhavi'¹⁹ or the wife of Anwar Hossain Munju although I was an elected MP. While I was entering into the Parliament session I had to hear that why I was alone? Why I had not come with my Husband? The situation was like that I would have to come with my husband in the Parliament every time' *The Prothom Alo*, dated March 13, 2006.

Actually it is a question of identity. The male members of society do not accept women as equal to them. Women suffer not only because of their identity; sometimes they are treated unjustly if they speak for their rights. In local governance, women's marginalization is reinforced by paternalistic and discriminatory attitudes of male representatives and male chairmen and their beliefs that women should not get involved in local politics, and that while men get into office on merit, women get in through government favors in the form of quotas (Mukhopadhyay, 2003). The following few cases will substantiate the above observation:

Hasnehena: A Case of Neglect

Hasnehena, Union Parishad Member said that "After my oath I went to the chairman and asked him to assign me some work. The chairman became annoyed and said that the government has brought out women from their homes to create unnecessary trouble in the Union Parishad. [He said] 'What will you do in the Union Parishad?' Go upstairs and sit with my wife and spend

your time. I do not find any work for you. No specific work is mentioned in the manual for women' (Mukhopadhyay and Meer (2004) *Creating Voice and Carving Space*, cited in Mukhopadhyay, 2005).

Aparna Rani: Story of Misfortune

Aparna Rani was a Union Parishad member of Moulvibazar. Her husband, who was a Primary School Teacher, encouraged Aparna to compete in the Union Parishad election. She was elected from the reserved seat. During the early stages of her time in the Union Parishad, Aparna did not face any problem but the situation changed later when she started to be more vocal than other women members and often argued with the chairman, which took a serious turn. The chairman did not support her active participation in the meetings and tried to teach her a lesson. A friendly male colleague used to help Aparna in performing different Union Parishad activities. The chairman spread rumors using Aparna's friendly relationship with her male colleague. This affected Aparna's married life. Finally she had to leave the Union Parishad (Shamim and Kumari, 2002).

The above cases substantiate how women are treated by their male counterparts at all levels. They are not only neglected but also face serious challenges which can destroy their family life. Under these circumstances, women lose interest to take part in the political process.

The next question which needs further elaboration is the case for Indian women in the Panchayati Raj System? Sen (2000) in her studies pointed out that reservation of seats for women in local government bodies has definitely opened the scope for women representatives. She also notes that Indian women fall behind men in all social and economic indexes. But she emphasizes the fact that it is the women who promote the interest of women in the process of national growth and development. The inference is that men cannot (for social or political reasons) or do not (to protect patriarchal authority) represent women's true interest. The concern is, therefore, to analyze to what extent are these women in a position to contribute to the local government decision

making process? Are they properly accepted by their male counterparts in the local body? Do they face any problem while participating in the activities of the local government?

Shamim and Kumari (2002) explained that there are two kinds of women representatives in the Panchayats: those who face problems and those who have had a smooth entry. Women representatives faced problems when they did not have any political or organizational affiliation, did not have any family members in politics and fought independently without any party support for which she had to contest in the elections. On the other hand, women who were associated with political parties, accepted party ticket for election and were elected without contesting and did not even make any promises had hardly any problems. One important point here is that of party affiliation, which plays a vital role in assuring good treatment for women. The situation may be favorable for the upper class women, but the lower class women are still the victims of negligence by their male counterparts.

Another aspect that needs to be mentioned here is the trend of exclusion of lower class women (dalit²⁰) from public office by council practice and procedures (Mukhopadhyaya, 2005). Several studies pointed to how dalit men and women are excluded from public office through the manipulation of official rules of procedure governing local government institutions. The case of Chaggibai studied by Goetz (2004) is an example:

Chaggibai: A Story of Victimization

Chaggibai was elected sarpanch of Rasulpura Panchayat, Rajasthan, India, in 1995, a chair reserved not just for a woman, but for a Dalit. A member of the tiny Bhil group, part of the Dalit community there, she was encouraged to run for the sarpanch position by members of the Rawat caste group, the elite class that made up over 60% of the residents of the area. As an independent-minded woman, she was not an obvious choice for an upper caste proxy candidate, as she was literate, known in the area as a woman's rights activist, a participant in the national level Mahila Samakhya program, and had worked as a school administrator. But she had long ago separated from her husband, and she

was seen therefore as more easy to manipulate than a married woman would be. At the first village assembly after her election, the local Rawat strong man who had always rung the local council, Charan Singh, conducted the meeting and refused to allow Chaggibai to speak. She had assembled over 400 women and Dalits from the area to attend, but Charan Singh, who was accustomed to conducting all council meeting in secret and from his own house, order them all to go home. Chaggibai mobilized the local Dalit and female community in the subsequent month to support her efforts to change council practices. She held open meetings to discuss local development plans, initiated projects to cover local drains, repair the school building and some roads, and she completed the Panchayat buildings so as to accommodate open sessions. When she led local women in demonstrations against the illegal liquor store run by the deputy sarpanch, Charan Singh and the Rawat community counter attacked, locking the Panchayat doors against her, hiding files containing illicit transactions, and attempting to assault Chaggibai. Subsequently, nine of twelve panchayat members, including two women, convened a secret meeting and passed a vote of no-confidence against her. Chaggibai's case was taken up by the People's Union of Civil Liberties and by Rajasthan's vibrant women's movement, and a petition was filed against her removal in the Jaipur High Court. In the end she did not succeed in getting reinstated. As she commented to a journalist several years later: 'they simple couldn't tolerate a woman. And above and beyond that, the panchayat is dominated by non-Dalits, so they couldn't tolerate me doubly. If I had been their puppet, as they expected me to be, none of this would have happened' (Goetz, 2002, cited in Mukhopadhyaya, 2005).

If we analyze the case of Chaggibai, two characteristics of Indian society will be evident. One would be that the Indian society still suffers from

caste struggle. The other would be the neglect of women. But, on the other hand, a number of studies find that women councilors and residents manage to articulate priorities in local planning and decision making differently from men. Basu (Nussbaum et al. 2003, cited in Mukhopadhyay, 2005) reports evidence from villages in Maharashtra, that women-led Panchayats placed greater emphasis on construction of wells, playgrounds, roads, public toilets and non-polluting stoves. Topalova (2003) found that drinking water supply services tended to be better in Panchayats led by women rather than men and the local residents agreed that women were less likely to demand bribes. Chattopadhyay and Duflo (2004) in their study on 165 village councils in West Bengal and Rajasthan found that women's leadership has indeed had positive impacts on policy decisions. On the other hand, Vijayalakshmi (2002) argues that a number of factors such as the way in which women are brought into the political process in local government institutions (as de jure and not de facto representatives), the fact that most women elected to reserved seats have no prior experience of politics or of contact with constituencies, that elected women have little communication with each other, that they belong to different social groups which divides them, limit the possibility of developing shared gender-specific agendas. The above discussion substantiates that the situation of women in India in comparison to Bangladesh is slightly better. Although they are the victims of several societal values, in some contexts they have been successful in playing a positive role.

Thus it is obvious that creating scope for participation of women through affirmative action by the government does not ensure their active participation in the decision making process; real participation of women in the local government decision making has not yet been ensured. The present level and style of women's participation can be referred to as merely symbolic. To ensure full women's participation it is necessary to overcome the rigid social and cultural barriers that they face and which limit their participation in the public sphere.

What should be done?

Despite having adopted new legal and institutional measures, in the form of reservation of seats in local government institutions by the government of Bangladesh and India to ensure greater participation of women in political process, the discussion of preceding section clearly demonstrates that such

representation is minimal and has been restricted mostly for the reserved seats. The major causes of such lower representation of women have been socio-cultural, political, structural, educational and regional factors. In such a situation, it is necessary to intensify existing measures and initiate new ones so that greater female representation in governance may be ensured.

First: A major obstacle to women's participation in politics involves cultural norms and perceptions that has stereotyped women's role to the family domain only. To counteract this, it is essential to initiate appropriate cultural, educational and informational policies. Both men and women should be taught the lesson that there is no difference between men and women, and women should be treated fairly and equally to make sure that discrimination against women is not acceptable. In doing so, the first step should be to redesign the educational curricula in a way that highlights the significance of women's participation in national development at all levels (Economic and Social Commission for Asia and the Pacific, 1993). Another mechanism would be to involve various media sources, like television, radio and newspapers, with a view to making policy-makers and administrators realize the problems of gender inequality and to stimulate women to reorganize their roles and affirm themselves as equal partners of men in every sphere (Center for Asia-Pacific Women in politics, 2000 and Haque, 2003).

Second: It is obligatory for the government to bring effective constitutional and legal provisions in regards to gender equality in every spheres of governance. Besides, it is always essential to pass few additional legal measures in order to render legislation effective. For instance, the Local Government (Union Parishad) Second Amendment Act 1997 does not have any clause where the duties and responsibilities of the women members have been clearly spelt out. In India, the provision of raising no confidence motion against the Sarpanch (the president) sometimes offers opportunity to the upper class powerful Panchayat member to remove the president who belongs to the schedule caste. This case of Chaggibai in Rajasthan, India is instructive. Taking these mistakes into consideration, specific laws in favor of enhancing women's representation in governing institutions needs to be passed in the parliament.

Third: Since women's representation in the legislative and executive bodies greatly depends on

their representation in political parties, there is need for the major political parties to take appropriate initiatives to expand such party representation. In this regard, they may, at least, practice the female quota in political parties. This system of female quota of political parties does exist in cases such as Denmark, Germany, Norway and Sweden (Women Around the World, 2000). In addition, it is the political will or commitment of top leaders that remains most critical to adopt and implement all the above measures suggested for ending gender-based discrimination and expanding female representation and participation in various domains of governance (Center for Asia-Pacific Women in politics, 2000). In the case of Bangladesh, it is easier to bring about such reforms in political parties as the two largest political parties are headed by women chairpersons

Finally: A government that does not consider women's empowerment a priority will more likely channel their budget to defense and trade promotion. Without an adequate budget, government initiated policy measures to empower women cannot possibly go beyond rhetoric. Political will must translate into both policies and resources if they are to be effective at all. At the same time, government policies must address the need to give women access to career patterns to develop and strengthen their capacity as political leaders, develop media relations, and generate their own resources (Villaluz, 2000).

Conclusion

The long history of struggles in South Asia--from women's suffrage to women's participation in electoral politics at national and provincial levels--is an ongoing process. The state's initiatives of granting quotas or reservation for women have proved to be a mixed bag. Still women of both Bangladesh and India have been facing numerous social, religious and political obstacles while participating in local level governance.

The essence of good governance lies in integrating local-level planning with national government policies and the success of local governments depend on peoples' participation. However, unequal participation of women and men in government affairs works as a barrier to ensure good governance in both Bangladesh and India (Shamim and Kumari, 2002). From the above analysis it is clear that there is a crucial need for a gender-specific development paradigm into all areas of policy making and planning, so that women's needs can be better met

and their participation ensured.

ENDNOTES

1. One may ask a question why 'local government' of both India and Bangladesh has been selected as the unit of analysis, why not national level? The answer lies in the fact that local government organizations are the main means through which women enter into the arena of politics. A vast majority of local level women do not have access to national level politics. Besides, it would have been a very difficult task to shed light on the state of women's political participation at the local as well as national level in a comparative perspective in a single paper.
2. India's bi-cameral legislature consists of a 545 strong lower house (Lok Sabha) and a 250 member upper house (Rajya Sabha). Women in the two houses largely belong to the relatively privileged middle class, are educated and professional. Some women enter through the caste quotas. Despite the constant low number of women having returned as legislators (though they doubled in the first fifty years) some have reached positions of power in mainstream political parties and in governance like Sonia Gandhi, president of the ruling Congress party, Jayalalitha, Chief Minister (CM) of Tamil Nadu and Mayawati, the former CM of Uttar Pradesh who also happened to be a *dalit*. Religious extremist party, Vishya Hindu Parishad (VHP) too has a few militant and activist women among its leadership. Notwithstanding their position these women have failed to push for gender balance in the decision making bodies within their parties. Women's representation in State Assemblies, at an average of four percent, is even more dismal. Analysis and studies of women's effectiveness in legislatures reveal that their presence has hardly made any difference despite the fact that women moved private members bills and resolutions relevant to women and managed support from other women members regardless of party lines. Most of these it turns out did not come up for discussions and lapsed (Mumtaz, 2005).
3. The system of local self government in rural areas in India is called Panchayati Raj. The system consists of the village (gram), block (taluka) and district (zila) levels.
4. Bangladesh's unicameral legislature consists of a

- parliament (*Jaityo Songhsod*) with 300 members. The constitution provided for 15 reserved seats for women (Clause 65), these were doubled to 30 in the second national assembly (1979-1982). The seats lapsed in 2001. In the year 2005, legislation was passed for restoration of reserved seats and increase in the quota to 45 seats. The women are indirectly elected by the members of the house. The quota does not prevent women from contesting on general seats. Currently there are 7 directly elected women in parliament. Unusual in the case of Bangladesh is that both the head of government and leader of opposition are women (Mumtaz, 2005).
5. A four-tier local government system is now in operation in Bangladesh. Among these four tiers, the top tier is the district council (*zilla parishad*); followed by the *upazilla parishad* which is the lowest level of operation for the bureaucracy and line ministries; the third tier is the union council (*union parishad*); and the fourth, village level *gram sarker*. Union parishad is the only local self government bodies in operation. So we would restrict our discussion of women's participation within the Union Parishad only.
 6. ADAB was the leading umbrella organizations of NGOs in Bangladesh.
 7. In 1996, a political turmoil took place in Bangladesh politics in regards to the controversial election of 15th February, 1996. All opposition political parties boycotted the election and was advocating for passing the bill of 'Non-partisan Care taker Government' to conduct a free and fair election in Bangladesh. Ignoring the opposition's demand, the then Government led by Prime Minister Begum Khaleda Zia went for contesting the election alone but the continuous mass movement compelled the Government to resign accepting the opposition demand for 'Non-partisan Care Taker Government'.
 8. GSS is the name of a NGO in Bangladesh.
 9. Nilphamari is the name of a district in Bangladesh.
 10. The prominent women leaders include Sonia Gandhi, president of ruling Congress Party, Kumari Jayalalitha, Chief Minister of Tamil Nadu, Mayawati, the former Chief Minister of Uttar Pradesh and Rabri Devi, the former Chief Minister of Bihar.
 11. One possible explanation might be that both leaders do not want to be gender biased by advocating for women or by initiating several affirmative actions designed for the improvement of women in Bangladesh.
 12. The population of Bangladesh is approximately 129 million: Muslims 88.3 percent, Hindus 10.5 percent, Buddhists 0.6 percent, Christians 0.3 percent, and animists 0.1 percent (http://banbeis.org/bd_pro.htm, 1 July 2004).
 13. 'Purdha' is a sort of veil used by the Muslim Women in Bangladesh for physical exclusion from the males.
 14. The term *fatwa*, which in Islamic legal parlance refers to a clarification of an ambiguous judicial point or an opinion by a jurist trained in Islamic law. In September 1993, a small group by the name of "Soldiers of Islam" announced a prize of fifty thousands taka (1 US\$ = 70 Taka) for the execution of writer Taslima Nasreen (who wrote several novels criticizing Islam) on the ground s that her works were insulting to Islam (Shehabuddin, 1999).
 15. *Mullah* is a term of address for one known or believed to be learned in religious matter.
 16. These factors are the constitutional adoption of Islam as the state religion, the growing aid dependency of the government on middle-eastern Islamic countries, the formation of successive governments with the supporting seats of the Jaamat-e-Islam party (Jaamat-e-Islam is the name of a political party whose main aim is to establish Islamic rule in Bangladesh) and the increasing governmental allocations to religious educational institutions (Shamim and Nasreen, 2002).
 17. 'De facto politics' refers to a political situation where despite being the elected representatives the person elected does not actively participate in the functions of governance. In case of women, the male family members and/or elites who were political actively managed the functions of the union parishad on behalf of women members (Vijaylakshmi 2002, cited in Mukhopadhyay, 2005).
 18. Anwar Hossain Munju is the Chairman of Jatio Party (Munju group) and also the existing Member of Parliament of Bangladesh.

19. In Bangladesh culture, wife of brother is generally called as 'bhavi'.
20. Dalit is the name of a caste belongs to Schedule Tribes.

REFERENCES

Ahmed, Shafi, et al., (2001) 'One Decade of Bangladesh Under Women Leadership', *Alochona Magazine*, October, p-3. (www. magazine. alochona.org/).

Ashman, Darcy (1997) 'The Democracy Awareness Education Program of Association of Development Agencies in Bangladesh (ADAB)', *Discourse, A Journal of Policy Studies*, Dhaka, Institute for Development Policy Analysis and Advocacy (IDPAA), Proshika.

Bardhan, Kalpana (1986) Women: Work, Welfare, and Status: forces of Tradition and Change in India, *South Asia Bulletin*, 1986, Vol. 6(1), pp.3-16.

Beall, J. (2004) '*Decentralization and Engendering Democracy: Lessons from Local Government Reform in South Africa*', Working Paper No. 54, November, Crisis States Program, Development Research Centre, Canada.

Beijing Platform for Action and Declaration (1995), Beijing, China, United Nations, Fourth World Conference on women.

Blair, H. (2000) Participation and Accountability at the Periphery: Democratic Local Governance in Six Countries, *World Development*, Vol.28, No.1, pp.21-39.

Caldwell, John (1982) *Theory of Fertility Decline*, London, Academic Press.

Center for Asia-Pacific Women in Politics (2000) *Women in Legislative Chambers: Asia-Pacific Region*; (Retrieved from: <http://www.capwip.org/participation/womenchambers.html>).

Chattopadhyay, Raghendra and Esther Duflo (2004) Impact of Reservation in Panchayati Raj: Evidence from a nationwide Randomized Experiment, *Economic and Political Weekly*, Vo. 39, No. 9, pp.979-986.

Chowdhury, Dr. Nazma (2002) *The Implementation*

of Quotas: Bangladesh Experience-Dependence and Marginality in Politics, Paper presented in Regional Workshop on the Implementation of Quotas: Asian Experiences, Organized by International Institute for Democracy and Electoral Assistance, Held on 25 September, 2002 in Jakarta, Indonesia.

Constitution of the People's Republic of Bangladesh, 1992.

Economic and Social Commission for Asia and the Pacific (1993) *Women in Politics in Asia and the Pacific*, United Nations, New York, pp-10-11.

Fikree, Fariyal F. and Omrana Pasha (2004) Role of Gender in Health Disparity: The South Asian Context, *BMJ*, Volume 328, downloaded from www.bmj.com, accessed on 3rd April, 2006.

Gala, Chetna (1996) "Empowering Women in Villages: All Women Village Councils in Maharashtra", Seminar report on "Decentralization and Devolution of Powers in Panchayati Raj System in India". 22-23 March, New Delhi, Centre for Development Studies and Action and FES (mimeo).

Goetz, Anne Marie (2004) 'Decentralization and Gender Equality', Chapter 12 in UNDP's *Striving for Gender Equality in an Unequal World*, UNDP Report for Beijing +10.

Haque, M. Shamsul (2003) 'Citizen Participation in Governance Through Representation: Issue of Gender in East Asia', *International Journal of Public Administration*, Vol. 26, no. 5, pp. 569-590, Marcel Dekker, Ins. USA.

Hashemi, S.M. (1995) 'NGO Accountability in Bangladesh: NGOs, State and Donors', in M. Edwards and D. Lewis (eds.) *NGO Performance and Accountability: Beyond the Magic Bullet*, Pp. 103-110, London, Earthscan.

Hensman, Rohini (1996) *The Role of Women in the Resistance to political Authoritarianism in Latin America and South Asia*, in Afshar, Haleh (ed) *Women and Politics in the Third World*, Routledge, London and New York.

Jayal, Nirja Gopal (1997) 'The Governance Agenda: Making Democratic Development Dispensable', *Economic and Political Weekly*, Vol. XXXII, No.8, February 22.

Kabir, Farah (2003) Political Participation of Women in South Asia (Retrieved from <http://www.dawnorg.org/publications/docs/prstkabir2003.doc>).

Karim, Anwarul (2000) *Recent Changes in the Structure of the Union Parishad in Bangladesh: Scope for Participation of Women*, An Unpublished M.Phil Thesis, Department of Administration and Organization Theory, University of Bergen, Norway.

Karin, Azza Et, al, (Eds) (1998) *Women in Parliaments: Beyond Numbers*, International Institute for Democracy and Electoral Assistance, Stockholm, Sweden.

Kaushik, Susheela (2000) Panchayat Raj and Women: A Profile, New Delhi, Centre for Development Studies and Action.

Khan, M. A. (2002) Knowledge on AIDS among Female Adolescents in Bangladesh: Evidence from the Bangladesh Demographic and Health Survey Data, *Journal of Health, Population and Nutrition*, Vol. 20 (2), June, pp. 130-137.

Landman, Tood (2003) *Issues and Methods in Comparative Politics: An Introduction* (2nd Edition), London; New York: Routledge.

Mathema, Madhuri (1998) Women in South Asia: Pakis, Bangladesh and Nepal, in Stromquist (ed.).

Matland, Richard E. (1998(b)), Enhancing Women's Political Participation: Legislative Recruitment and Electoral Systems, in *Women in Parliament: Beyond Numbers*, Karim, Azza (Ed), International IDEA, Handbook Series 2.

Mazumder, Vina and Indu Agnihorti (1999) "The Women's Movement in India, Emergence of a New Perspective", in Bharati Ray and Aparna Basu (Eds.) *From Independence to Freedom*, New Delhi:OUP.

Mohanty, Bidyut (1999) 'Panchyat Raj Institutions and Women' in Bharati Ray and Aparna Basu (Eds.) *From Independence to Freedom*, New Delhi:OUP.

Mohon, Shantha et al., (2003) "Women and Political Participation in India, Base Line Report, National Institute of Advance Studies-Gender Studies Unit (NIAS), International Women's Rights Action Watch Asia Pacific, Kuala Lumpur, Malaysia.

Mukhopadhyay, Maitrayee (2005) *Decentralization and Gender Equity in South Asia: An Issue Paper*, The International Development of Research centre, Canada.

Mukhopadhyay, Maitrayee (Ed.) (2003) *Governing for Equity: Gender, Citizenship and Governance*, Conference Proceedings, Royal Tropical Institute, KIT Development Policy and Practice, Amsterdam, The Netherlands.

Mukhopadhyay, Maitrayee and Sharmin Meer (2004) *Creative Voice and Carving Space, Redefining Governance from a Gender perspective*, KIT Publishers, Amsterdam, Netherlands.

Mumtaz, Khawar (2005) Women's Representation, Effectiveness and Leadership in South Asia, paper presented in Fifth South Asia Regional Ministerial Conference: Celebrating Beijing Plus Ten, Islamabad, Pakistan, 3-5, May.

Narasimhan, Shakuntala (1998) "Gusty Rustic", *Decent Herald*, August 16.

Nussbaum, M et, al (eds.) (2003) *Essays on Gender and Governance*, Human Development Resource Centre, United Nations development Program, New Delhi, India.

Rustagi, Dr. Preet (2004) Women and Development in South Asia, *South Asian Journal*, Vol.4, South Asia Media Net, Lahore, Pakistan, April-June.

Shehabuddin, Elora (1999) Contesting the Illicit: Gender and the Politics of Fatwas in Bangladesh, *Signs: Journal of Women in Culture and Society*, Vol. 24, No. 4, pp. 1011-1044.

Shamim, Ishrat (1999) Women in Local Governance: Bangladesh Perspective, Paper Presented at the Workshop on *Participation of Women in Local Government: Problems and Prospects*, Organized by Centre for Development Studies and Action and Fredrich Ebert Stiftung, New Delhi.

Shamim, Ishrat and Mahbuba Nasreen (2002) Gender and Local Governance: A New Discourse in Development, *The Journal of Social Studies*, Centre for Social Studies, Dhaka, Vol. 94/95, October-March (Joint Issue), Pp. 50-87.

Shamim, Ishrat and Ranjana Kumar (2002) *Gender and Local Governance: A New Discourse in*

Development, South Asia Network of Economic Research Institutes, Islamabad, Pakistan.

Shamim, Ishrat (2004) "Women and Local Governance: Has it Empowered Women", Paper presented at Regional Conference on Gender and Governance, 16-18 December, Islamabad.

Sultana, Abeda (2000), 'The Role of Training in the Empowerment of Women in Union Parishad: An Analysis', *Lok Proshashon Samoyke*, No 17, December, Dhaka.

Tambiah, Yasmin (2002) Women and Governance in South Asia: Re-imagining the State, Colombo, ICES. *The Prothom Alo*, A Widely Circulated National Bengali Dailies, Dhaka, Bangladesh, dated March 13, 2006.

UNDP (2000) *Women's Political Participation and Good Governance: Twenty First Century Challenges*, New York.

UNFPA (2000) Partnering A New Approach to Sexual and Reproductive Health, Technical Paper No. 3, New York.

Vijayalakshmi, V (2002) *Gender, Accountability and Political Representation in Local Government*, Working Paper No. 102, Institute for Social and Economic Change, Bangalore, India.

Villaluz, Sheila Espine (ed) (2000), *Women Around the World Fact Sheet, A Quarterly Fact Sheet of the Center for Legislative Development*, Dhaka, June, Vol.1, No-4.

Villareal, M. (1998) Construction of Masculinity(ies): Implications for sexual and Reproductive Health, Paper presented at TSS Thematic Workshop on Male Involvement in Sexual and Reproductive Health Programs and Services, UNFPA, Rome, 9-13 November.

Women Around the World (2000) Quota System: Women's boon or bane? Vol.1(3).

Pranab Kumar Panday is currently pursuing his doctoral research in the Department of Public and Social Administration at City University of Hong Kong. He is an Associate Professor in the Department of Public Administration at the University of Rajshahi, Bangladesh. He may be contacted at pranabpanday@yahoo.com.

ARSENIC MITIGATION TECHNOLOGIES IN BANGLADESH: EVIDENCE FROM THE LITERATURE

N. Nahar and T. Honda

ABSTRACT

Bangladesh is the worst affected country in the world in terms of global arsenic contamination in groundwater. Contaminated drinking water has posed severe health problems in rural Bangladesh. The provision of arsenic free water is urgently needed now to mitigate arsenic toxicity and to protect health. This paper provides an overview on arsenic mitigation technologies developed and practiced in Bangladesh. Alternative sources of safe water and treatment of arsenic contaminated groundwater are also presented. It discusses the conventional technologies for arsenic removal including some technologies that utilize indigenous materials for arsenic removal. It also discusses the best available techniques and offers cost comparisons among these techniques. Technical and economic viability, and indigenous capacity, in association with ultra sensitivity, is the essence of successful implementation of arsenic mitigation technology. For all technologies, hygiene education is essential to risk management. Importantly, community-based management is needed to operate and maintain the water sources efficiently in rural Bangladesh.

Introduction

The alluvial Ganges aquifers of Bangladesh, comprising most of the drinking water supply, are heavily contaminated with arsenic beyond the safe limit prescribed by WHO (10 µg/l) and this has negated the idea of using shallow tubewells for safe drinking water throughout the country. In 61 out of the 64 districts there is arsenic in groundwater, and more than 30% of the tested 4.37 million tubewells are contaminated with arsenic at rates far beyond the safe limit (NAISU, 2000). The mortality rate from arsenic poisoning in Bangladesh is expected to rise substantially in the near future (Paul and De, 2000). Arsenic in the drinking water of Bangladesh has emerged as a serious environmental and health problem in the country (Fazal, et al., 2001, Hossain, 2002). Analysis of screening data of 268 out of 465 Upazilas shows that about 30% of the tubewells in the affected areas are contaminated. The number of villages with more than 80% tubewells contaminated is 8,546 (BAMWSP, 2004). A total of 38,430 cases of arsenicosis have been identified under a national screening program (Ahmed et al., 2005a). Nowhere is there a group of people more vulnerable and less prepared to deal with such a massive environmental health catastrophe. It represents the largest known mass poisoning from exposure to arsenic contaminated drinking water in history (Rabbani et al., 2002). Treatment of arsenic toxicity has no effective cure, but drinking arsenic-free water along with nutritious food can help get rid of the symptoms of arsenic toxicity (van Leeuwen, 2000). Thus, chronic arsenicosis is reversible when treated early by drinking clean water and taking vitamins. Unfortunately, most of the people in the arsenic contaminated areas do not have access to safe drinking

water which threatens their very survival.

During the last 6-7 years many arsenic mitigation technologies have been developed in Bangladesh. This paper intends to provide answers to the questions: what are the technological developments in arsenic mitigation processes and how can 'community-based' management system be achieved for sustainable mitigation of arsenic contamination in rural Bangladesh? The study is based on a literature survey and discusses briefly the 'background of the problem and problems caused by arsenic contamination. The following sections focus on the mitigation technologies and suggest a community-based management system for sustainable arsenic mitigation. The final section provides a conclusion.

Background of the Problem

Bangladesh is one of the most heavily populated countries in the world. Until the early 1970s, a majority of the rural people of Bangladesh obtained drinking water from shallow hand-dug wells, rivers and ponds. But these sources caused epidemics such as diarrhea, aemebiasis, typhoid and other water-borne diseases. The poor surface water quality compelled the authorities to develop a groundwater supply system in Bangladesh. This led aid agencies such as UNICEF and others to spend millions of dollars sinking tubewells. Following this example, the rural people of Bangladesh later sank many more tubewells privately. There are approximately 4.5 million public tubewells installed by government departments in Bangladesh (Jones, 2000), whereas it was only about 50,000 during the British colonial rule (UNICEF, 1999). The tubewell initiative is said to have contributed significantly to halving infant and under-five mortality

rates in Bangladesh between 1960 and 1996. But the recent discovery of arsenic in groundwater has ruined this decade-long success and access to safe drinking water. It is estimated that 35-57 million of the approximately 138 million people of Bangladesh are at risk of drinking arsenic contaminated water (BGS and DPHE, 2001). The Chief of Water and Environmental Sanitation of UNICEF opines that Bangladesh has become the victim of its own success (Independent, 2000).

Arsenic was first detected in tubewell water (at Barogharia union of Chapai Nawabganj district) by the Department of Public Health Engineering (DPHE) Bangladesh in 1993 (Ahmed, 2000). But it received widespread attention in early 1995 when arsenic contamination was found to be present across central and southern Bangladesh (Paul and De, 2000). The greatest concentration of affected wells is in the south and east of Bangladesh, and in the 12 worst affected districts [Chandpur, Faridpur, Munshiganj, Gopalganj, Lakshmipur, Noakhali, Bagerhat, Shariatpur, Comilla, Faridpur, Shatkhira and Meherpur]. The least concentration of arsenic is in the north-west and in the areas of north central-Bangladesh (Ahmed, 2002). In arsenic-contaminated areas, the large degree of well-to-well variation within a village means that it is difficult to predict whether a given well will be contaminated from tests carried out on neighboring wells. The median arsenic concentration is 135 μ g/l and 76% of the shallow wells exceed the Bangladesh standard (50 μ g/l). Roughly 60% or more of the wells in each of the worst-affected districts contain arsenic concentrations exceeding the Bangladesh standard and occasionally exceeded 1000 μ g/l (Kinniburgh and Kosmus, 2002). It was also reported by van Geen et al. (2003) that the mean arsenic concentration in water where the community wells are installed is 180 \pm 140 μ g/l. An estimated 50 million people in Bangladesh are drinking water with arsenic concentrations exceeding the current Bangladesh standard (Mondal et al., 2006).

Arsenic contamination of groundwater has become one of the world's largest health concerns, occurring in a number of different countries and endangering the health of millions of people. A chart of the countries with arsenic contamination is shown in Table-1: Bangladesh is the worst affected country.

Several arsenic mitigation technologies are used in the above countries and may be grouped based on sources of water, types of treatment required to make water drinkable, types of service and other characteristics. Some of the options are based on treating surface

water and some are based on treating the arsenic-contaminated ground water. In Bangladesh, it is very important to have different alternative safe water options because of cultural and socio-economic variations among communities. The alternatives include surface water, groundwater, and rainwater.

Problems Caused by Arsenic Contamination in Bangladesh

In this section the health, economic, social and related problems are highlighted for rural Bangladesh.

Health Problems

Rahman and Axelson (1999) speculated that long-term drinking of water containing 50 μ g/l of arsenic may ultimately result in death from arsenic induced cancer. The scale is well beyond the disasters in Bhopal India 1984 and Chernobyl, Ukraine, in 1986. On the basis of simulating data of Samta village of Jessore district, Curry et al. (2000) predicted that after 30 years, more than 22% of the villagers were likely to be attacked by arsenicosis and 5.5% of them were likely to die, if the inhabitants continued to drink from the same tubewells. The DPHE of Bangladesh indicated that about 75 million people belonging to 59 districts out of the country's 64 districts are estimated to be clinically and sub-clinically arsenicosis victims (Jakariya, 2000). Milton et al. (2001) have tried to relate chronic arsenic poisoning to respiratory effects among Bangladeshis. With an average of 614 μ gm/l exposure, the overall crude prevalence ratio for chronic bronchitis was 2.3 persons and women were 6 times more likely to be suffering from the disease as compared to men. Recently, Clarke (2003) reported that arsenic from tainted tubewell water could contribute to nearly 125,000 cases of skin cancer and kill 3,000 people in Bangladesh each year. So far 38,430 patients have been registered officially in Bangladesh as suffering from arsenicosis (BAMWSP, 2004), but the actual number is suspected to be much higher. There is fear that the number could increase rapidly if the contaminated wells continue to be used for drinking water (Smith, et al., 2002). In one study, excess risks for spontaneous abortion and stillbirth were observed among the participants chronically exposed to higher concentrations of arsenic in drinking water (Milton, et al., 2005). There is also strong evidence of arsenicosis and arsenic-induced cancer patients in Bangladesh.

Social Problems

Clinical symptoms, as well as a number of social and

societal problems are aggravating the situation. Nasreen (2002) reports the onset of social problems such as social instability, superstition, ostracism, marital problems, and discrimination against women, increased poverty, diminished working ability, and death. People are reluctant to develop marital relationships with families whose members suffer from arsenicosis. This has caused serious anxiety for parents of unmarried adult children. The social consequences of this are far-reaching and tragic

(Hassan, 2003). Children of arsenic patients are not allowed to attend social or religious functions or even school (Hassan et al., 2005). They also are subject to social ostracism by their friends and classmates. This will lead to changes in work responsibilities inside and outside the home for all family members and in the case of children to changes in school attendance. Very recently a survey by the author in Charghat Thana in Rajshahi district revealed that women affected by arsenic poisoning are being socially

Table 1: Global Arsenic Contamination in Groundwater

Country	Exposed population (Million)	Concentration (µg/l)	Environmental conditions
Argentina	2	1 to 9,900	Natural; loess and volcanic rocks, thermal springs; high alkalinity
Bangladesh	30	1 to 2,500	Natural; alluvial/deltaic sediments with high phosphate organics.
Bolivia	0.05	-	Natural and similar to Chile and parts of Argentina.
Brazil	-	0.4 to 350	Gold mining.
Cambodia		More than 50	
Chile	0.4	100 to 1,000	Natural and anthropogenic; volcanogenic sediments; closed basin lakes, thermal springs and mining.
China	>0.0005	40 to 750	Natural; alluvial sediments.
Dominica, Frances, Kamchatka	-	-	Arsenic associated with geothermal waters has also been reported in several areas, including hot springs
Finland		17-980	-
Germany	-	10 to 150	Natural ; mineralized sandstone.
Greece	0.15	-	Natural & anthropogenic, thermal springs & mining.
Hungary, Romania	0.4	2 to 176	Natural; alluvial sediments; organics.
Inner Mongolia	0.1 to 0.6	1 to 2,400	Natural; alluvial and lake sediments, alkalinity.
Japan	-	0.001-0.293	Natural origin.
Myanmar		More than 50	
Mexico	0.4	8 to 620	Natural and anthropogenic; volcanogenic sediments; mining.
Nepal	-	More than 50	
New Zealand	-	38	
Pakistan	-	Up to 900	
Spain	0.05	1 to 100	Natural; alluvial sediments.
Taiwan	0.1 to 0.2	10 to 1,820	Natural; coastal zones, black shales.
Thailand	0.15	1 to 5,000	Anthropogenic; mining and dredged alluvium.
U.K	-	1 to 80	Mining; southwest England.
USA and Canada	-	1 to 100,000	Natural and anthropogenic; mining pesticides, As ₂ O ₃ stockpiles, thermal springs, alluvial, closed basin lakes, various rocks.
Vietnam	>1	1 to 3,050	Natural; alluvial sediments.
West Bengal, India	6	10 to 3,200	Natural; alluvial/deltaic sediments with high phosphate organics.

Source: This table is constructed from the data available in the literature (Nordstrom 2002; Mondal et al., 2006)

discriminated against in the community. Poor women affected by the disease are not hired for domestic work. They suffer from inferiority complex because of the visible effects of the disease. Although arsenicosis is not infectious, contagious or hereditary; it can create serious social problems for the victims and their families.

Gender Problems

Gender discrimination exists in many forms in the patriarchal society of Bangladesh; women suffer more than men. In rural Bangladesh women do most of the household work, including collecting and carrying of water for household use. Arsenic contamination in nearby drinking water often compels them to collect and carry water from a long distance, which uses up a huge amount of time and labor, and imposes an additional burden on them. The economic value of their time has never been estimated. If the women could use this time and effort for other productive activities, they could contribute more to their families financially. Because of socio-cultural restrictions, women often do not receive information from outside sources. Thus, they are also not properly made aware of the danger posed by arsenic. This makes arsenic mitigation activities difficult.

Economic Problems

The Asia Arsenic Network conducted a demographic survey of Samta Village in Jessore District of Bangladesh in 1998 (Tani, 1999). There were no arsenicosis patients with annual income above Tk.140, 000. Increasing levels of household income are associated with a lower prevalence of arsenicosis. The results of a recent survey by the author in some villages of North-Western Bangladesh confirmed the validity of this relationship; e.g., in the villages where arsenicosis was found, annual income was not greater than Tk.110, 000 per annum (Nahar, 2006). Arsenicosis decreases the victim's ability to work; he or she often suffers from reduced income. Arsenic patients also lose their jobs due to ostracism. The poverty stricken are the main victims of arsenic contamination as they are compelled to drink arsenic polluted tubewell water. Due to their poverty, arsenic victims are deprived of proper treatment. Thus, arsenic pollution adversely affects the poverty situation in Bangladesh.

Soil Pollution

Even if arsenic-safe drinking water is ensured, arsenic polluted groundwater will continue to be used for irrigation purposes in Bangladesh. Between 30 and 40 percent of the net cultivable area of Bangladesh is

under irrigation using groundwater (Huq and Naidu, 2002). Extensive withdrawal of arsenic contaminated groundwater contaminates surface soils and plants and thus affects the food chain (Das et al., 2003). Since 1990, irrigation coverage has been increased significantly to raise food production levels. The contribution of groundwater in relation to total irrigated area increased from 41 percent in 1982-1983 to 71 percent in 1996-1997 and to over 75 percent in 2001 (Ali et al., 2003). The presence of arsenic in irrigation water results in significant increases of arsenic concentration (average is less than 10mg/Kg, (Huq et. al, 2003) in the irrigated soil, particularly in the top layer (Ali et al., 2003), which creates a risk of soil accumulation and thus reducing its productivity.

Mitigation of Arsenic Contamination in Rural Bangladesh

Comprehensive reviews of arsenic removal processes have been reported in the literature (Ahmed et. al. 2005, Mandal et al, 2006). Advances in arsenic removal technologies (Jackel, 1994) and economic factors involved in implementing lower drinking water stands for arsenic (Chen et al., 1999) are presented in the literature. Murcott (2000) has reviewed low-cost, well-water treatment technologies for arsenic removal with the list of companies and organization involved in arsenic removal technologies. The American Water works Association (AWWA) conducted a study on arsenic treatability options and evaluation of residuals management issues (AWWA 1999). Many technologies for treatment of arsenic contaminated water at household and community levels have been developed and installed in different parts of Bangladesh. Some have shown good potential—the technologies that are used to provide safe drinking water in rural Bangladesh are discussed next.

Conventional Arsenic Removal Technologies in Bangladesh

The most commonly used conventional technologies for removal of arsenic from water can be grouped into the following four categories:

- (a) Oxidation and precipitation (Wegelin et al., 2000)
- (b) Coagulation and filtration (Ali et al., 2003).
- (c) Sorptive filtration (Ahmed et al., 2005)
- (d) Membrane filtration (EPA, 2002)

There are several issues relating to the safety of these technologies in terms of microbial, chemical and physical quality of water and disposal of wastes from the arsenic removal processes. The common

limitations of these techniques are: (i) difficulties of handling chemicals, (ii) production of arsenic contaminated sludge, (iii) high installation and operation costs, and (iv) removal efficiency hindered by sulphates, ions, and pH levels. These considerations have led to a systematic evaluation of arsenic removal technologies under Environmental Technology Verification- Arsenic Mitigation (ETV-AM) program by Bangladesh Council of Scientific and Industrial Research (BCSIR) in collaboration with Ontario Centre for Environmental Technology Advancement (OCETA), Canada (BCSIR, 2003). BCSIR has recommended four technologies using adsorption and oxidation methods. They fulfilled conditions of deployment for a period of two years and are known as (i) ALCAN, (ii) READ-F, (iii) SONO 45-25 and (iv) SIDKO. However, these four technologies performed very differently in the different hydro geological conditions. So, regional geological characteristics are an important factor in the choice of a technology.

Among the conventional techniques the following have been defined as the best available technologies (BAT) for arsenic removal: (i) Anion exchange, (ii) Activated alumina, (iii) Reverse osmosis, (iv) Modified coagulation/filtration, (v) Modified lime softening and (vi) Oxidation/filtration and green sand filtration (Mondal et al., 2006). Among these processes coagulation–filtration and lime softening

techniques are cheaper but the removal efficiency of these techniques is low. The adsorptive process with activated alumina is the most inexpensive among the techniques with higher efficiency (higher than 95%). For ground water systems without pre treatment in-place, the most suitable treatment technologies are ion exchange and activated alumina.

Advantages and Disadvantages of Conventional Arsenic Removal Technologies

During the last few years remarkable technological Development has been taking place in arsenic removal from rural water supply based on conventional arsenic removal processes in Bangladesh. A comparison of the different processes is shown in Table 2. In these processes the output includes waste products and drinking water (having different concentration of arsenic less than 50µg/l). In all these technologies, a comprehensive evaluation of alternative processes requires not only evaluation of the quantity and quality of drinking water, but also of the quantity and quality of solid waste. Many of these waste products result in welfare losses that are ordinarily not mitigated through market mechanisms. Welfare generated within the economy from extraction of resources and welfare losses associated removal from rural water supply based on conventional arsenic

Table 2: A comparison of Conventional Arsenic Removal Technologies in Bangladesh

Technologies	Advantages	Disadvantages
<u>Oxidation/Precipitation</u> Air Oxidation; Chemical oxidation.	Relatively simple, low cost but slow process; Relatively simple and rapid process (chemicals); Oxidizes other impurities and kills microbes	The processes remove only a part of arsenic; Used as pretreatment for other processes
<u>Coagulation and Filtration</u> Alum Coagulation Iron Coagulation Lime softening	Relatively low capital cost; Relatively simple operation; Common chemicals available	Not ideal for anion rich water treatment; Produces toxic sludge; Low removal of As (III); Pre-oxidation may be required; pH adjustment required; Efficiencies may be inadequate to meet arsenic rich strict standard.
<u>Sorption Techniques</u> Activated Alumina Iron Coated Sand Ion Exchange Resin Other Sorbents	Relatively well known and commercially available; Well defined technique; Plenty possibilities and scope of development	Produces arsenic rich liquid and solid waste; Replacement/ regeneration is required; High-tech operation and maintenance; Relatively high cost
<u>Membrane Techniques</u> Nanofiltration Reverse Osmosis Electrodialysis	Well defined and high removal efficiency; No toxic solid waste produced; Capable of removal of other contaminant	High capital and running cost; High tech operation and maintenance; Arsenic rich rejected water produced

Source: Ahmed (2002, 2003)

removal processes in Bangladesh. A comparison of the different processes is shown in Table 2. In these processes the output includes waste products and drinking water (having different concentration of arsenic less than 50µg/l). In all these technologies, a comprehensive evaluation of alternative processes requires not only evaluation of the quantity and quality of drinking water, but also of the quantity and quality of solid waste. Many of these waste products result in welfare losses that are ordinarily not mitigated through market mechanisms. Welfare generated within the economy from extraction of resources and welfare losses associated with waste generation are closely related (Baumol and Oates, 1988).

The challenge lies in identifying the most suitable technologies for treating arsenic contaminated groundwater in rural Bangladesh. Very recently Robinson (2005) proposed a conceptual design procedure for a solution to the problem of arsenic contaminated drinking water in Bangladesh on the basis of “The 12 Principles of Green Engineering” (Anastas and Zimmerman, 2003), which provide a framework for designing new materials, products, processes, and systems that address human health, environmental, economic and social factors of the community.

Alternative Sources of Safe Water in Bangladesh

The Implementation Plan for Arsenic Mitigation in Bangladesh (GOB, 2004) identified the following alternative technologies for arsenic-safe water supply based on technical, social and economic considerations:

- Dug well (DW)
- Surface Water Treatment: (a) Pond Sand Filter (PSF),
(b) Large-scale Surface Water Treatment
- Rainwater Harvesting System (RWHS)
- Deep Tubewell (DTW)
- Piped Water supply System

Dug-well

Dug well (DW) is the oldest method of groundwater withdrawal for water supplies. It has been observed that the dug-well water, though coming from almost the same layer as the shallow tube-wells, does not contain arsenic above the maximum permissible limit. (Ahmed, 2002). The traditional DWs could be upgraded into sanitary dug-wells (Sikder and Hoque, 2002) by including a hand pump and a filter unit, which will remove turbidity and microbes. Different

types of pumps are used to draw water from the covered DWs (Majed, 2005), which include: (a) DWs with tubewell or hand pump, (b) DWs with Row pump, (c) DWs with Tara pump and (d) DWs with motorized pump. One sanitary dug-well is capable of supplying almost 1000 liters of water per day. Thus, the sanitary dug-well might be an affordable and sustainable option for the poor people of rural Bangladesh (van Geen et al., 2003). A study in an acute arsenic problem area showed that frequent withdrawal of water initiated ingress of arsenic contaminated water in dug wells (JICA-AAN, 2004). Since the upper layer of soil contains organic debris, dug well water is often characterized by bad smell, high turbidity and color, and high ammonia content. Bangladesh has developed a protocol for installation of dug/ring wells (GOB, 2004).

Dug wells have not proved successful in many areas of Bangladesh that have thick impermeable surface layer and low water table. Although tubewells in Bangladesh have replaced traditional DWs in most places, about 1.3 million people in both urban and rural areas still depend on DW for drinking water supply (GOB, 2002). A recent study by Ahmed et al., (2005) suggests that DW water needs better sanitary protection and disinfection which is likely to be of particular importance during the monsoon season.

Surface Water Treatment

The available surface water in Bangladesh is highly turbid in both dry and wet seasons: in the dry season, there is excessive growth of algae in pond and lake water, while in the wet season, rainwater drainage from the catchment area brings a lot of suspended sediment and makes the surface water highly turbid (Jakariya et al., 2003). This source is however relatively free from arsenic, which can be purified by passing water through a special filter bed of sand or other locally available equivalent materials, known as pond sand filter (PSF), able to serve more than 200 people per unit (Begum and Karim, 2000). These are constructed by the side of a pond, which contains an adequate quantity of water throughout the year. A PSF system comprised of a Horizontal roughing filter (HRF) and a slow sand filter (SSF), has the ability to decrease turbidity and bacteria in raw water efficiently (Yokata et al., 2001). (Safiuddin and Karim, 2003; Jakariya et al., 2003). Lessons suggest that where other alternative sources exist, PSF soon becomes non-functional due to lack of proper maintenance. However, in areas where surface water is the only source of drinking water PSF is a well-maintained popular water supply technology and it has been given priority in the National Policy for Arsenic Mitigation

(GOB, 2004). Polluted surface water can be purified by simple boiling; ultraviolet radiation such as sunlight (solar radiation), and chemicals such as chlorine and ozone could be used for disinfection. Solar water disinfection is a simple and low-cost water treatment method to improve the microbiological quality of drinking water (Wegelin and Sommer, 1998).

One of the main problems associated with the construction of PSF is the availability of ponds that are reserved only for PSF. Fish culture in ponds is popular in rural Bangladesh as it generates direct income. People are therefore reluctant to offer their ponds to be used for PSF instead of fish culture. Also, surface water is not available in dry seasons in some areas, and ponds and rivers become turbid and, in some cases, waterless. Social acceptability of treated surface water as an alternative to tubewell water is very low. People believe that surface water should be avoided for drinking in order to be safe from water borne diseases (Ahmed, 2000, Grameen Bank, 2000). In order for PSF and surface water filtration to be effective, the water should be free of fertilizers and other chemical contamination. Fulfilling this condition is very difficult in Bangladesh.

Rain Water Harvesting System (RWHS)

Dhaka Water Supply Sewerage Authority (WASA) has verified that rainwater is free from bacteria and other pollutants (Begum and Karim, 2000). Rainwater harvesting, therefore, can be practiced as another preference in the community based water supply system. For this, sustainable collection, storage and distribution methods need to be developed based on the existing practices in India, Maldives, Thailand and some of the Caribbean countries (Saifudin and Karim, 2003). RWHS is comparatively good, easy to maintain, and less vulnerable to contamination. However, rainwater is essentially lacking in minerals and some minerals like calcium, magnesium, iron and fluoride are considered essential for human body in appropriate proportions. The lack of mineral content may affect its consumption. In a study carried out by BAMWSP during 2002, it was found that 34% of the respondents did not drink rainwater for its lack of taste (Ahmed et al., 2005a)

An action research project on RWHS was carried out in two upazilas in Rajshahi district in 2003. It was found that the acceptability of the water from RWHS was high and cost of maintenance was low. It is a potentially safe, reliable and affordable alternative source of water supply for drinking and cooking for at least 8-10 months of the year (Rahman et al., 2005). In

addition, proper education and training should also be provided with state of the art options for storage and distribution of rainwater in order to avoid microbiological contamination. Rainwater harvesting should be given high priority to mitigate the arsenic disaster in Bangladesh.

RWHS is most suitable in the coastal islands, southwestern part of coastal area and hilly regions of Bangladesh where water of adequate quantity and good quality from other ground and surface water sources are limited. But, this household based technology with provision for adequate storage tank for year around water supply is comparatively costly.

Deep Tubewell (DTW)

In Bangladesh two types of DTW are installed; manually operated small diameter tubewells similar to shallow tubewells and large diameter power driven DTWs called production wells. Manually operated DTWs are a source of safe and reliable water supply in many parts of the coastal areas. DPHE has sunk a total of 82,384 DTWs mainly in the coastal area to provide safe water to 8.2 million people (DPHE, 2000). It is reported that of DTW with a depth greater than 150 meters, only about 1% have levels of arsenic above 50 µg/l, and 5% have arsenic levels above 10 µg/l (BGS-DPHE 2001). As such, deep aquifers separated from shallow contaminated aquifers by impermeable layers can be a dependable groundwater source of arsenic-safe water. The annular spaces of the boreholes of the deep tubewells must be sealed, at least at the level of the impermeable strata, to avoid percolation of arsenic contaminated water (Ahmed 2004). A protocol for the installation of deep tubewells for arsenic mitigation has been developed in Bangladesh (GOB, 2004).

Treatment of DTW water can effectively make use of a huge number of DTWs, declared abandoned for yielding water with high arsenic content. Also, the rural people will not be required to immediately shift to an unfamiliar technology other than the tubewell to which they have been habituated for the last three decades. Possibility of arsenic contamination in DTWs is less if it is constructed properly, the aquifer tapped is underneath a thick clay barrier (Chakorabarty, 2006) and involves test for other contaminants.

Piped Water Supply System (PWSS)

This is the ultimate goal of safe water supply in rural Bangladesh because piped water is protected from external contamination and water can be delivered in

close proximity to the consumers. It allows a more effective operational response and better quality control through monitoring. Institutional arrangements for operation and maintenance are feasible, and water of required quantity can be collected with ease. Rural piped water supply has received priority for arsenic mitigation in Bangladesh and a large number of pilot schemes by different organizations are under implementation (Ahmed et al. 2005). It is reported that the rural people in arsenic affected areas of Bangladesh are willing to pay for piped water (Ahmad et al, 2005). Piped water supplies are also possible for clustered households in villages, growth centers and the rural areas having good rural road network. Arsenic safe water for piped water supplies will be available from any sources such as deep tube well, treated surface or arsenic contaminated water or water from community dug wells.

Recently Ahmad et al., (2006) reported that rural households are willing to pay for piped water supply and they prefer it compared to six arsenic mitigation technologies: three-kolshi (pitcher) method, activated alumina method (household-based and community-based), dugwell, pond sand filter and deep tubewell (handpump). The survey results indicate that, after taking into consideration the initial and recurring costs, convenience, associated risks and the advantages and disadvantages of each selected technology, the preference of the rural people is overwhelmingly in favor of deep tubewells, followed by the three-kolshi method. The analysis also reveals a strong demand for piped water in both arsenic-affected and arsenic-free rural areas. Between piped water and other arsenic mitigation technologies, the preference of the rural people is found to be predominantly in favor of the former.

Updated progress in Arsenic Mitigation options

Up to the end of July 2005 there were almost 107,000 alternative water supplies (as shown in Table-3) installed in arsenic affected areas under arsenic mitigation program, which cover 38 per cent of the population of Bangladesh.

Recently, Ahmed et al., (2005a) developed a Quantitative Health Risk Assessment (QHRA) model of alternative water supply options identified in the implementation plan for arsenic mitigation in Bangladesh. According to this model only DTW in the dry season had a median risk that was close to the WHO reference level of risk for microbial quality. Lower confidence levels for DTW in both dry and wet seasons and RWHS in the wet season also meet or

approach the reference level of risk. DW and PSF do not meet the reference level of risk under any conditions. The model shows that there is significant health risk substitution for DWs and PSFs with respect to pathogens. There is much lower risk substitution in DTWs and RWHSs in relation to either pathogens or other chemicals. Hence, DTW had the highest aggregate water quality followed by RWHS, while DW and PSF had the lowest aggregate water safety. The disease burden increased in the wet season with greater deterioration of microbial water quality of DW.

In Bangladesh, estimates show that the present population coverage by piped water supply is 13.1 million (10%) and manually operated deep tube well mainly in the coastal area is 8.1 million (6%). Dug/ring well, Pond Sand Filter, Very Shallow Shrouded Tubewell and rainwater harvesting provide arsenic safe water to 2.8 million (2%). About 103 million (80%) people depend on shallow tubewell (Hand Pumped Tubewells, HPTWs) for water supply and remaining 2% people do not have any well-defined source of water supply. (Hossain, 2002)

Treatment of Arsenic Contaminated Groundwater in Bangladesh

Groundwater often provides a water supply that is more reliable in quantity and more stable in quality than surface water and thus has economic and operational advantages due to reduced treatment requirements (Robins, 1990). Water is one of the most important carriers through which arsenic enters the human body. As the diagnosis and medication of the arsenic related diseases are difficult, the treatment of contaminated water as a preventive measure appears to be an effective alternative in the short term to combat arsenic poisoning.

There are several filters available in Bangladesh that use indigenous material as arsenic adsorbent. Red soil rich in oxidized iron, clay minerals, iron ore, iron scrap or fillings and processed cellulose materials are known to have capacity for arsenic adsorption. Some of the filters manufactured using these materials are:

Sono 3-Kolshi Filter

It uses zero valent iron fillings and coarse sand in the top Kolshi, wood coke and fine sand in the middle Kolshi while the bottom Kolshi is the collector of the filtered water (Khan et al., 2000,). The technique is very popular, very effective in removing arsenic, inexpensive and very simple to construct by the villagers (BAMWSP, DFID and Water Aid, 2001). But

Table 3: Update mitigation options installed by stakeholder (up to July.2005)

Stakeholder	DW	PSF	RWH	DTW	AIRP	PWSS	SST	DSP	Total
AAN	38	13	0	9	0	1	2	0	63
BAMWSP	739	12	3,001	1,867	0	0	0	0	5,619
BRDB	227	0	95	14	0	0	0	0	336
DCH	81	5	11	0	0	15	0	0	112
DPHE-UNICEF	1,552	321	7,472	403	0	4	205	0	9,957
IDE	268	0	804	0	0	0	0	0	1,072
NGO Forum	241	47	384	85	702	4	0	23	1,486
World Vision	106	490	1,205	0	353	0	0	0	2,154
Others	29	23	147	7	0	0	0	0	206
Arsenic mitigation programs	3,281	911	13,119	2,385	1,055	24	207	23	21,005
DPHE-DANIDA	2	20	132	14,706	2	9	0	0	14,871
GOBIV	2,985	2,590	73	57,718	2,714	0	4,873	110	71,063
All Programs	6,268	3,521	13,324	74,809	3,771	33	5,080	133	106,939

Source: The Independent (2006), “Arsenic Mitigation Progress in Bangladesh” Updated Findings from the APSU Monitoring Program, Dhaka, Bangladesh, 16 January.

there are shortcomings, such as water flow rate is low, filters clog, and water is not available quickly.

Granet Home-made Filter

It contains relatively inert materials like brick chips and sand as filtering media. No chemical is added to the system. It did not show reliable results in different areas of Bangladesh and under different operating conditions (Ahmed, 2001).

Chari Filter

This also uses brick chips and inert aggregates in different Charis as filter media. The effectiveness of this filter in arsenic removal is not known (Ahmed, 2001).

Adarsha Filter

It uses clay material as filter media in the form of candle. This filter failed to meet the technical criterion of reducing arsenic to acceptable levels (BAMWSP, DFID and WaterAid, 2001).

Shafi Filter

It is based on filtration and direct co-precipitation which have good arsenic removal capacity (40 liters of treated water per day) but suffered from clogging of filter media (BAMWSP, DFID and Water Aid Bangladesh, 2001; Ahmed 2003)

Bijoypur Clay /Processed Cellulose Filter

It is capable of adsorbing both As (III) and As (V) in

solutions acidified with vinegar or hydrochloric acid. Workable exposure length, flow rate and extract volume demonstrated arsenic removal at least or even below 0.050 mg/l. (Khair, 1999). Based on arsenic removal studies in Bangladesh, Meng and Korfiatis (2001) concluded that elevated levels of phosphate and silicate in Bangladesh well water dramatically decreased adsorption of arsenic by ferric hydroxides.

Household Bucket Filter

It is based on the principles of co-precipitation and filtration. This is very simple, cost-effective, more efficient, user-friendly and able to supply about 50 liters of water per day (Meng et al., 2001). The efficiency of the system is described by Meng and Korfiatis (2001). The experimental units installed by the DPHE-Danida project are serving clusters of families and educational institutions (Ahmed et al.2005).

Cost Estimation in Arsenic Mitigation Technologies in Bangladesh

Boerschke and Stewart (2001) have proposed an empirical formula for cost estimation in arsenic mitigation technologies in Bangladesh as shown in Equation-1,

$$R = PV/(1 + X)^Y (1)$$

Where (PV) is the purchase price, (Y) is amortization over a number of years, (X) is the annual interest rate and (R) is the annual cost. The unit of R is Taka (Tk) per annum. Risk associated with any variable, such as the transport of the technology/required chemicals,

use of chemicals, operational accidents, negligence, and disposal of byproducts, are calculated and added to the unit cost.

The quality and quantity of water, reliability, cost and convenience of collection for the different options vary widely and depend on the effectiveness and capacity of each option in producing arsenic free water. The costs of installation, daily capacity and cost per family from various organization involved in arsenic mitigation are summarized in Table 4. The cost analysis includes the installation cost only.

Data in Table 4 show that Three Pitcher Filter and BTU are the cheapest options (Tk300-Tk400). Pond Sand Filter is quite affordable if the community is involved and could be a promising option for a price of \$8 provided there is availability of ponds. Shafi Filter, Deep Tubewell, Dugwell, Rain Water Harvesting options are within the price range of Tk 900 to Tk 1800. The Piped Water Supply is the most expensive, costing Tk 5000 per family.

A recent study by Koundouri (2005) showed that the results of cost-benefit analysis (CBA) for arsenic mitigation techniques and policies in Bangladesh are positive under varying levels of success in terms of their effectiveness depending on the concentration of arsenic in the water, the chemical composition of the water (including interfering particles), the amount of water to be treated, the feasibility and overall cost of the treatment process. Cost benefit analysis implies that developing mitigation methods based on indigenous knowledge of the people is very important. Instead of treating contaminated water, use and management of other alternative forms of safe water, such as rainwater, surface water and deep aquifer water is more sustainable.

Community-based management system for sustainable arsenic mitigation technology in rural Bangladesh

It is evident from the literature survey that although many technologies for treatment of arsenic contaminated water at the household and community levels have been developed and installed in different parts of Bangladesh, there are no simple and inexpensive technologies available to mitigate the problem, especially in the case of isolated rural households. Some have shown good but limited potential for use in arsenic-safe water supply in affected areas, while others have serious drawbacks. Also, the suitability of a technology varies among the communities that use the technology. Social and cultural factors are important in the adoption and

diffusion of a technology. Rural people have developed the habit of using hand tubewell water over the last 30 years. So any change in their behavior needs a friendly approach and technology that is geared to their needs. Sustaining behavioral change in use of water should be considered in all mitigation programs.

According to Mondal et al. (2006), the success or acceptance of the process of a particular arsenic removal technology in the community depends on the following factors: (i) maximum contaminated level target, (ii) arsenic concentration, (iii) user population, (iv) region where the system is located, (v) source of water, (vi) whether the water-supply system has existing treatment in place, (vii) co-occurrence of solutes and (viii) waste disposal issues.

The current situation in rural Bangladesh is either that most of the villagers already have a tubewell (arsenic contaminated) or they are sharing tubewells with neighbors. At the same time it is true that obtaining water from tubewells is very easy because there is hardly any maintenance involved whereas regular maintenance, that is also complex, required for the provided options. This makes community people reluctant to accept mitigation options. However, they are willing to pay for options for which operation is easier, maintenance cost is low and time commitment is low (Jakariya, 2000 ; Nahar, 2006).

Most rural development programs cannot meet the demand of the community because of the absence of appropriate institutional mechanisms, and most programs simply cannot reach the large low-income groups. An initiative from several Bangladeshi organizations has resulted in international cooperation According to the Arsenic Mitigation and Research Foundation (AMRF). local priorities are a significant component in the decisions regarding mitigation options (Crelis and Boes, 2004). Given the institutional weakness of governmental bodies in within a reasonable time, it is natural to look for community-based solutions based on local experience, knowledge and capacity. There must be a greater role for the community in achieving a sustainable rural water management system involving formal institutions as well as informal networks at village community level.

To establish a community-based mitigation system, village mitigation committees are needed to be formed in the affected villages to perform the whole range of local arsenic mitigation activities. This will promote community participation, which is often lacking in the whole process of mitigation encompassing area

Table 4: Costs for different options in arsenic mitigation technologies in Bangladesh.

Alternative Options	Unit Cost TK/\$ ²	Daily Drinking Water Capacity	Cost per Family TK/\$
Rainwater Harvesting	1800/30	515L	1800/30
Bucket Treatment Unit (BTU)	(300-400)/(5-6)	One Family	(300-400)/(5-6)
Three Pitcher Filter	(250-300)/(4-5)	One Family	(250-300)/(4-5)
Chari Filter	(300-400)/(5-6)	One Family	(300-400)/(5-6)
Shafi Filter	900/15	One Family	900/15
Deep Tubewell	50000/ 835	50 Families	1000/ 17
Dugwell	60000/ 1000	40 Families	1500/25
Pond Sand Filters	40000/667	90 Families	500/8
Piped Water Supply	20, 00,000/ 3333	400 Families	5000/ 83

Source: This table is constructed from data available in the literature (Hamel and Zinia, 2001; BRAC, 2000).

assessment, pre-installation, installation, post-operative and management issues. NGO workers and donor authorities may also be included in the committee along with local members. Through this committee, it would be easier to maintain coordination among the mitigation workers, which is crucial for achieving its goal. There should be good networking among the various committees, such as Upazila Arsenic Control Committee, District Arsenic Control Committee at the regional levels and the DPHE at the national level. There can be a Upazila-wise plan for arsenic mitigation that will outline which technology is best suited for that Upazila, taking into consideration the arsenicosis situation, geological and socio-economic factors.

Anstiss et al. (2001) have reported about a sustainable community-based arsenic mitigation project operated successfully in the Chapainawabganj hot spot where there has been close community involvement in all stages. The arsenic removal mechanism was the simple process of adsorption by natural ferric oxyhydroxide.

At present the NGO Forum in all regions¹ has been organizing training courses for sustainable community-based arsenic mitigation management. The arsenic issue is regularly discussed at the NGO Forum's promotional activities such as courtyard meeting and local discussion forum to avoid possible panic in the community and to help them in taking necessary preventive measures. The process that leads to community management for dealing with the arsenic crisis is shown in the flow chart (Figure. 1).

Until now, there are about 102 community-based arsenic removal technologies that are installed in different arsenic contaminated areas of Bangladesh (APSU, 2005). The success of the community-based implementation of alternative water supply options is

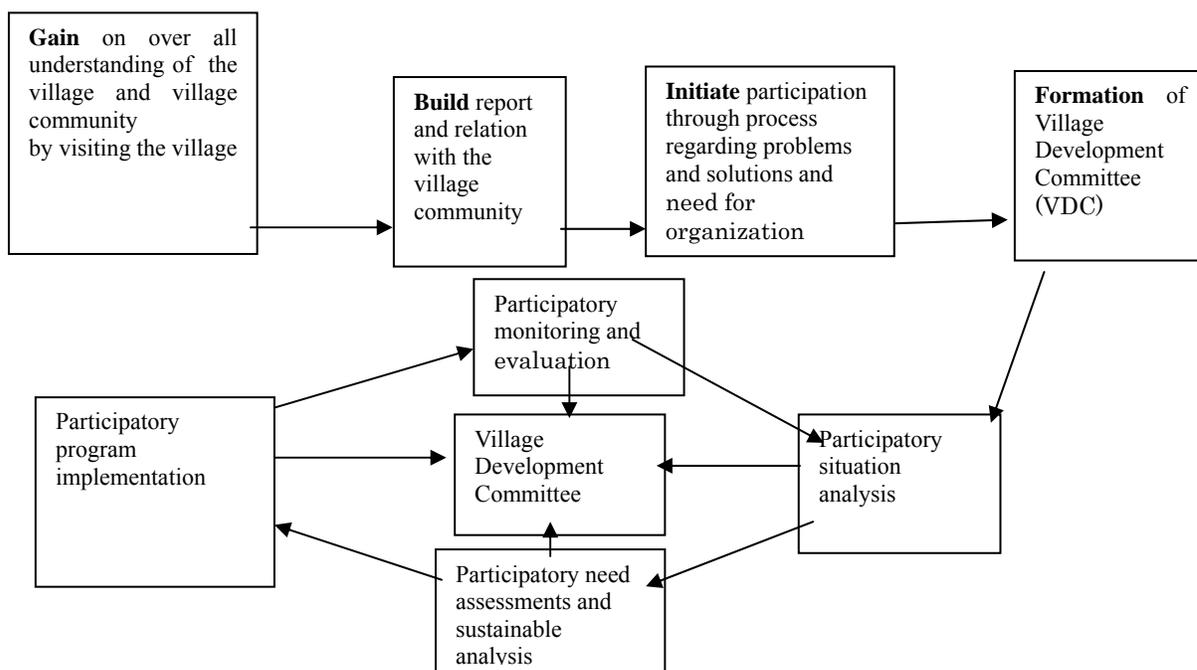
dependent on the participation of truly empowered communities driven by explicit and committed demand for improved water supply systems. Capacity building activities of the local government institutions is a prerequisite to ensure sustainability of water supply system. Co-ordination between government and the NGOs is vital both for earning community trust and for the sustainable implementation of the provided options. Through such a procedure, a safe water option will be accepted by the community as a technically suitable, socially acceptable and financially sustainable mitigation technology.

Conclusion

The potential impact of arsenic contamination of groundwater on public health and the rural household economy have placed arsenic as a top-priority water quality issue. The alternative options available for safe water supply in the arsenic affected areas include arsenic avoidance by using alternative sources of safe water and treatment of arsenic contaminated groundwater. The first option includes treatment of surface waters by low cost methods, rain water-harvesting, extraction of water from shallow aquifers by dugwells and deep aquifers by deep tubewell. Such uses of alternative sources require a major technological shift in water supply. The second option is treatment of arsenic contaminated water for the removal of arsenic. Treatment of tubewell water can effectively make use of a huge number of tubewells declared abandoned for yielding water with high arsenic content.

Removal of arsenic from water is possible by ultraviolet radiation, oxidation, chemical precipitation and filtration. However each of these methods can face problems in terms of efficiency. The avoidance of arsenic is also possible by the use of surface water, rainwater, and alternative groundwater sources. DTWs and RWHS have much lower risk substitution.

Figure. 1 Process Leading to Community Management in arsenic mitigation.



Source: NGO Forum Office, Rajshahi, 2006.

DTW has the highest aggregate water quality followed by RWHS, while DW and PSF provide the lowest aggregate water safety. A comprehensive water distribution system and a national water resources management policy should be implemented in order to limit the indiscriminate extraction of water from the ground. Sustainable water supply systems based on surface water and/or rainwater should be developed in those affected areas where groundwater is severely contaminated by arsenic. Hygiene education to the rural users is essential to avoid other health risks in using the alternative water sources. Arsenic free shallow tubewells should continue to be used, and concurrently, other groundwater sources need to be established for safe water. All technologies described in this article have their merits and demerits. The implementation of the technologies are in progress with the following objectives: i. Improve effectiveness of arsenic removal, ii. Reduce the capital and operation cost of the systems, iii. Make the technology user friendly in the community, iv. Overcome maintenance problems and resolve sludge and arsenic concentrates management problems.

The local community should be fully involved in the planning and the development of the water supply system, and all concerned people should partake in the managerial and financial responsibilities. The success

of the community-based implementation of arsenic mitigation options is dependent on participation of truly empowered communities driven by explicit and committed demand for improved water supply systems.

Continuous monitoring and evaluation is necessary to check the arsenic contamination levels and also the safety of the mitigation options. Coordination is needed among the different stakeholders not only to avoid repetition of activities but also to find mitigation packages that are acceptable to the community. The government must cooperate with academic as well as research institutes to assess the causes and impact of arsenic poisoning and take up remedial measures whenever and wherever necessary. No technology should be allowed for marketing without proper testing and validation from Bangladesh Council for Scientific and Industrial Research. Cost sharing in mitigation should be considered from long term and sustainability perspectives. Affordability for the poor and access to safe water for all should be given maximum priority.

REFERENCES

Ahmed, H.S. (2000), "Combating a deadly menace: Early experience with a community-biased Arsenic Mitigation Project in Bangladesh", Dhaka. BRAC.

- Ahmed M.F. (2001), "An Overview of Arsenic Removal Technologies, in Bangladesh and India" International workshop on Technologies for Arsenic Removal from Drinking Water, May 2001, P. 251
- Ahmed, M.F. (2002), "Arsenic Mitigation in Bangladesh", International Workshop in Bangladesh, 14-16 January. Publ.: ITN-BCWSWM, BUET, Dhaka-1000 .
- Ahmed, M. F. (2003). "Treatment of Arsenic Contaminated Water." In: M. F. Ahmed, ed., Arsenic Contamination: Bangladesh Perspective. P.354-403. Dhaka, Bangladesh: ITN-Bangladesh.
- Ahmed, M.F. (2004), "Cost of Water Supply Options form Arsenic Mitigation." In: People-Centered Approached to Water and Environmental Sanitation, Preprint, 30th WEDC International Conference 600-603. Vientiane, Lao PDR
- Ahmed, M.F., Minnatullah, K.M. and Talbi. A. (2005), "Arsenic Mitigation Technologies in South and East Asia," VOL II Technical Report, Paper 3, World Bank. <http://siteresources.worldbank.org/INTSAREGTOPW/ATRES/Resources/ArsenicVolIIPaperIII>.
- Ahmed, M.F., Mahmud, S. S., Rashid, H., Deere, D. and Howard, G. (2005a), "Risk assessment of arsenic mitigation Options (RAAMO)", APSU, Dhaka.
- Ahmad, J., Golder. B. Misra, S. (2005), "Values of Arsenic-free drinking water to rural households in Bangladesh", Journal of Environmental Management, Vol.74, No-2, P.173-185.
- Ahmad, J., Misra, S. and Golder , B. (2006). "Rural communities' preferences for arsenic mitigation options in Bangladesh". J Water Health, Vol.4, P. 463-477
- Ali, M. A., Badruzzaman, A. B. M., Jalil, M. A., Hossain, M.D., Ahmed, M.F., Masud, A. A., Kamruzzaman. M, and Rahman, M. A. (2003), "Fate of Arsenic Extracted With Groundwater." Paper presented in the International Symposium on 'Fate of Arsenic in the Environment' Organized by BUET, Bangladesh and United Nation University, Japan. At Dhaka.
- Anastas, L. and Zimmerman. (2003), "Design Through the 12 Principles of Green Engineering". Journal of Environmental Science and Technology. Vol.94A , P.101A.
- Anstiss, R., Arewgoda. M., Ahmed. M., Islam. S., and Khan. A.W., (2001). A sustainable community-based arsenic mitigation pilot project in Bangladesh. *International Journal of Environmental Health Research*, Vol.11 (3), P.267-274.
- APSU (2005), "Progress With Provision of Arsenic Mitigation Options to the end of December 2004", Arsenic Policy Support Unit
- AWWA (American Water Works Association). (1999), "Arsenic Treatability Options and Evaluation of Residuals Management Options."AWWA Research Foundation.
- BAMWSP, DFID and Water Aid Bangladesh (2001). "Rapid Assessment of Household Level Arsenic Removal Technologies, Phase-I and Phase II, Final Report, WS Atkins International Ltd.
- BAMWSP (2004), News Letter, Bangladesh Arsenic Mitigation Water Supply Project, September
- Baumol, W.J. and Oates, E., (1988). "The Theory of Environmental Policy". Cambridge University Press, Cambridge.
- Boerschke, R. K. and Stewart, .D. K. (2001), "Evaluation of Arsenic Mitigation Technologies for Use in Bangladesh". *Technologies for Arsenic Removal from Drinking Water. Internet source on March 2006.* <http://www.unv.edu/env/Arsenic/Boerschke.pdf>
- BRAC (2000). "Combating a deadly menace: early experience with a community-based arsenic mitigation project in Bangladesh". Research Monograph Series No. 16. Dhaka.
- BCSIR (2003), "Performance Evaluation and Verification of Five Arsenic Removal Technologies". ETV-AM Field Testing and Technology Verification Program: Phase-I.
- Begum, Z. R. and Karim, M. M. (2000), "Arsenic Groundwater Contamination of Bangladesh: Community Participation in Groundwater Resources Management, Proceedings of 93rd Annual Meeting of Air & Waste Management Association, Salt Lake, USA, 18-22 June 2000, P. 1-10.
- BGS and DPHE (2001), "Arsenic Contamination of Groundwater in Bangladesh", Kinnburg, D.G and Smedley. P.L. (Editors). Volume 2: BGS Final Report WC/00/19.

- Chakorabarty, D. (2006), “Major Issues to be Addressed to Combat Arsenic Crisis in Ganga–Meghana-Brahmaputra (GMB) Plain”. Paper presented in 6th International Conference on ‘Safe Water and Safe Food Options in Arsenic Mitigation Lesson Learnt’, DCH, 4th January, 2006.
- Chen, H.W., Frey, M.M., Clifford, D., McNeill, L.S. and Edwards, M. (1999), “Arsenic Treatment Considerations”, Journal of American Water Works Association, Vol.-91(3), P.74-85
- Clarke, T. (2003), “Well water could be killing 3000 Bangladeshis each year”, Nature Review, July 2.
- Crelis, F. and Boes. R.J. (2004), “Arsenic mitigation and social mobilization in Bangladesh”. Vol.5(3), P. 308-319
- Curry, A., Carrin, G., Barteaux, J., Yamamura, S., Heijnen, H., Sims, J., Hueb, J., and Sato, Y. (2000), “Towards an Assessment of the Socioeconomic Impact of Arsenic Poisoning in Bangladesh,” A monograph prepared for the World Health Organization (Department of Health in Sustainable Development and Water, Sanitation and Health) Geneva.
- Das, H. K, Chowdhury, D., Rahman, A., Obaidullah, S., Miah, M.U., Gupta, S.P, and Islam, F. (2003), “Arsenic Contamination of Soil and water and Related Bio-hazards in Bangladesh”. Paper presented in the International Symposium on ‘Fate of Arsenic in the Environment’ Organized by BUET, Bangladesh and United Nation University, Japan. Dhaka.
- DPHE (2000), “Arsenic in groundwater: Testing pollution mechanisms for sedimentary aquifers in Bangladesh’, DPHE Bhobon, Dhaka.
- EPA (United States Environmental Protection Agency), (2002), “Arsenic in Drinking Water Treatment Technologies: Removal”. www.epa.gov/ogwdw000/ars/treat.html.
- Fazal, M.A., et al. (2001), “Extent and severity of groundwater arsenic contamination in Bangladesh”, Water International, Vol. -26, P.370-379.
- GOB (2002), “Arsenic Mitigation in Bangladesh”, Ahmed, M.F and Ahmed C.M. (Eds) Local Government Division, Ministry of LGRD &Co-operatives, Government of Bangladesh.
- GOB (2004), “National Policy for Arsenic Mitigation 2004 and Implementation Plan for Arsenic Mitigation in Bangladesh”. Government of Bangladesh, Ministry of Local Government, Rural Development and Cooperatives, Local Government Division.
- Grameen Bank (2000), “Completion Report of Action Research on Community Based Arsenic Mitigation Project” (A GB-DPHE-UNICEF project), Dhaka: Grameen Bank.
- Hassan, M. M. (2003), “Arsenic poisoning in Bangladesh: Health and social hazard”. Ph.D. thesis, University of Durham, U.K.
- Hassan, M. M., Atkins, P. J. and Dunn, C. E. (2005), “Social implications of arsenic poisoning in Bangladesh.” Social Science & Medicine, Vol 61, P.2201-2211.
- Hamel, N.E. and Zinia, K.N. (2001), “A study of arsenic treatment technologies and leaching characteristics of arsenics contaminated sludge”. In M.F. Ahmed, M.A. Ali & Z. Adeel (Eds.), Technologies for arsenic removal from drinking water (P. 208). Dhaka: BUET.
- Hossain, M.A. (2002). “Arsenic contamination in drinking water and environmental threats: Mitigation perspectives in Bangladesh”. Regional Development Dialogue, Vol. 23, P.85-105
- Huq, S.M.I. and R. Naidu. (2002), “Arsenic in Groundwater of Bangladesh: Contamination in the Food Chain”. In Arsenic Contamination in Bangladesh, International Training Network Centre (ITN). Dhaka.
- Huq, S.M.I., Rahman, A., Sultana, N. and Naidu, R. (2003), “Extent and Severity of Arsenic contamination in Soils of Bangladesh”. Paper presented in the International Symposium on ‘Fate of Arsenic in the Environment’ organized by BUET, Bangladesh and United Nation University, Japan, at Dhaka. February, pp.69-84
- Independent (2000), The daily English Newspaper in Bangladesh. February, 27, 2000.
- Jackel, M. R. (1994), “Removal of Arsenic in drinking water treatment”. In J.O Nriago (Ed.) Arsenic in Environment, Part-1: Cycling and Characterization, John Wiley & Sons. Inc., New York.
- JICA-AAN. (2004), “Water Quality and Follow-up Survey on Arsenic Contamination of Dug Wells in Sharsha Upazila, Bangladesh.” Japan International Cooperation Agency and Asia Arsenic Network.

- Jakariya, M. (2000), *“The use of alternative safe water options to mitigate the arsenic problem in Bangladesh: a community perspective”*. M.Sc. Thesis, Department of Geography, University of Cambridge, Aug 2000
- Jakariya, M., Chowdhury, A. M. R., Hossain, Z., Rahman, M. and Sarker, M. A.Q. (2003), *“Sustainable community-based safe water options to mitigate the Bangladesh arsenic catastrophe – An experience from two upazilas”*. Current Science, Vol. 85, No. 2.
- Jones, E.M. (2000), *“Arsenic 2000: An Overview of the Arsenic Issue in Bangladesh”*, Draft Final Report (Dhaka: Water Aid Bangladesh, December 2000).
- Khan, A.H. and Alam. (2000), *“Appraisal of a simple arsenic removal method for groundwater of Bangladesh”*. Journal of Environmental Science and Health. Vol. A35 (7), P.1021-1041
- Khair, A. (1999), *“Arsenic removal from drinking water by low-cost materials”*, Paper presented at the International Conference on Arsenic in Bangladesh Groundwater: World’s Greatest Arsenic Calamity, USA, February 27-28.
- Kinniburgh, D.G. and Kosmus, W. (2002), *“Arsenic contamination in groundwater: some analytical considerations”*, Talanta, Vol.-58, P.165-180.
- Koundouri, P. (2005), *“The Economics of arsenic mitigation”*, World Bank Technical Report-II, Paper-4 ‘Arsenic contamination of ground water in South and East Asian Countries’. P. 210-267.
- Mondal, P., Majumder, C.B. and Mohanty, B. (2006), *“Laboratory based approaches for Arsenic remediation from contaminated water”*, J. Hazard Mater. 2006 Feb 28.
- Majed, N. (2005), *“Contamination of Dug Well water and its Control”*, M.Sc. Engg. Thesis, Department of Civil Engineering, BUET, Bangladesh.
- Meng X.G., Korfiatis, G. P., Christodoulatos, C. and Bang, S. B. (2001). *“Treatment of arsenic in Bangladesh well water using a household co-precipitation and filtration system”*. Water Resources, Vol.-35(12), P. 2805-2810
- Meng, X. G. and Korfiatis, G.P. (2001), *“Removal of Arsenic from Bangladesh Well Water Using Household Filtration System.”* In: Ahmed, M. F., M. A. Ali, and Z. Adeel, Eds. *Technologies for Arsenic Removal from Drinking Water* 121–130. Bangladesh University of Engineering & Technology and United Nations University.
- Milton, A.H., Hasan, Z., Rahman, A. and Rahman, M. (2001), *“Chronic Arsenic poisoning and respiratory effects in Bangladesh”*. Journal of Occupational Health, Vol.43, P.16-140
- Milton, A H., Smith, W., Rahman, B., Hasan, Z., Kulsum, U., Dear, K., Rakbuddin, M. and Ali. A. (2005), *“Chronic Arsenic Exposure and Adverse Pregnancy Outcomes in Bangladesh”*. Epidemiology. Vol.16(1), P. 82-86, January 2005.
- Murcott, S. (2000), *“A comprehensive Review of Low cost, Well water Treatment Technologies for Arsenic removal”*, <http://hys4.harvard.edu/~wilson/murcott2.html>.
- NAISU (NGO’s Arsenic Information and Support Unit) (2000), *“An Overview of Arsenic Issues and Mitigation Initiation in Bangladesh”*, page-68. <http://www.naisu.info>
- Nahar, N. (2006), *“Impacts of Arsenic Contamination in Groundwater on a Village Production System: Case study of Affected Villages in Bangladesh”*. Ph. D Thesis. Japan Advanced Institute of Science and Technology. Japan. September.
- Nasreen, M. (2002). *“Social Impact of Arsenicosis. in Arsenic Contamination in Bangladesh”*, (Dhaka: ITN Bangladesh).
- Nordstrom, D. K. (2002), *“Worldwide Occurrences of Arsenic in Ground Water”*, Science, Vol.-296, P.2143.
- Paul, B.K. and De, .S. (2000), *“Arsenic poisoning in Bangladesh: geographical analysis.”* Journal of the American Water Resources Association. Vol.-36, p.799-809
- Rabbani, GH, Chowdhury, A.K., Shaha, S.K. and Nasis, M. (2002), *“Mass arsenic poisoning of ground water in Bangladesh”*. Global health Council Annual Conference, Washington DC, May28-June1.
- Rahman, M. M., Sarker, P.C. and Rahman, Z. (2005), *“Rainwater Harvesting Technical and social Evaluation in Two Arsenic Affected Upazilas of Rajshahi”*. NGO Forum for Drinking Water and Supply, Dhaka.
- Rahman, M. and Axelon. (1999), *“Hypertension and arsenic exposure in Bangladesh”*, Hypertension, Vol. 33, P.74-78.

Robins, N.S. (1990). "Hydrology of Scotland". HMSO, London.

Robinson, B. (2005), "Arsenic Removal Through Phytoremediation an Appropriate, Sustainable, Environmental Solution for Bangladesh," Sustainable development Research Competition Engineers without Borders, Canada, April.

Safiuddin, M. and Karim, M.M. (2003), "Water resources management in the remediation of ground water arsenic contamination in Bangladesh" Aquatic Arsenic toxicity and treatment, pp. 1-17. Edited by T. Murphy and J. Guo 2003 Backhuys Publishers, Leiden, The Netherlands.

Smith, A.H., Lingas, E.O. and Rahman .M. (2002), "Contamination of drinking water by arsenic in Bangladesh: a public health emergency", Bull. World Health Organ. Vol.-78(9), P.1093-1103

Tani, M. (1999), "Data set on demographic field work on Arsenic in Samta Village". Sponsored by the Asia Arsenic Network in Feb. 1998 to March 1999.

Trudgill, S.T. (1990), "Barriers to a better environment: what stops us solving environmental problems?"

The Independent (2006), "Arsenic Mitigation Progress in Bangladesh" Updated Findings from the APSU Monitoring Program, Dhaka, Bangladesh, 16 January

UNICEF. (1999), "Arsenic Mitigation in Bangladesh:

media brief". UNICEF, Bangladesh.

van Geen, A., Ahmed, K. M., Seddique, A. and Shamsudduha, M. (2003), "Community wells to mitigate the arsenic crisis in Bangladesh", Bulletin of the World Health Organization 2003,

Van Leeuwen, F.X.R. (2000), "Safe drinking water: the toxicologist's approach", Food and Chem. Toxicology, Vol.-38(1). P. S51-S58

Wegelin, M. and Sommer, B. (1998), "Solar water disinfection (SODIS) - destined for worldwide use?" Waterlines, Vol.-16, P.333-347.

Wegelin, M., Geehter, D., Hug, S., Mahmud, A. and Motaleb, A. (2000), "SORAS - A Simple Arsenic Removal Process". Phys4-arvad.edu/Wilson/mitigation/SORAS_paper.html

Yokota, H., Tanabe, K., Sezaki, M., Akiyoshi, Y., Miyata, T., Kawahara, K., Tsushima, S., Takafuji, H., Rahman M., Ahmad S. A., Sayed M.H.S.U. and Faruquee M.H.(2001), "Arsenic contamination of ground and pond water and water purification system using pond water in Banglades" Engineering Geology, Volume 60, Number 1, P. 323-331

ENDNOTES

1. Upaziala is equivalent to a sub-district. In Bangladesh, the zila, or district, is the administrative unit. There are 507 upazilas and 64 districts in the country.

<p>N. Nahar and T. Honda Department of Knowledge System Science, Japan Advanced Institute of Science & Technology. Ishikawa 923-1292, JAPAN. e-mail: nnahar@jaist.ac.jp</p>

PROBLEMS AND PROSPECTS OF SHRIMP AND RICE-PRAWN GHER FARMING SYSTEM IN BANGLADESH

Basanta Kumar Barmon, Kondo Takumi and Fumio Osanami

ABSTRACT

The second largest export industry in Bangladesh is the shrimp industry and its contribution is about 4.7% to GDP and 9.38% of total exports. Given its importance to the economy, the present study attempts to explain the problems and prospects of shrimp/prawn gher farming system in Bangladesh. Case studies and secondary data were used in the present study. The findings indicated that the shrimp-gher farming system has a negative impact on the environment, ecology, land degradation, livestock, and water quality, whereas the rice-prawn gher farming system is friendlier to environments, ecology, and water quality and helps alleviate poverty. The rice-prawn gher farming system has significant impacts on land for modern varieties (MV) paddy production. The yield of MV paddy production under rice-prawn gher farming system is almost the same as the yield in other parts of Bangladesh where the farmers usually produce only year-round MV paddy. The rice-prawn gher farming system is providing a sufficient amount of rice, fish and vegetables to small, marginal and landless farmers that would not be possible under shrimp gher farming. The rice-prawn gher farming system will be sustainable if the government takes necessary steps for its development.

Introduction

The shrimp/prawn producing unit in Bangladesh is locally known as “gher” farming. Gher farming is a combined form of aquaculture and agriculture. Shrimp/prawn gher farming system has significant impacts on agriculture and the economy of Bangladesh and has created many diversified local job opportunities like mud snail traders, prawn fingerlings traders, ice factory, depot owners, etc. A large number of male and female workers supply their labor in this sector. The basic components of one’s standard of living such as food consumption, medical care, education, housing, and clothing have improved after the introduction of the gher revolution. Now the people in this industry can have three meals a day which was not possible in the recent past. They can also afford to send their children to school for education (Barmon et al, 2004). The agricultural system as well as cropping patterns have changed since the development of export-oriented shrimp and freshwater rice-prawn gher farming that have influenced the land contractual agreement from traditional sharecropping to fixed cash rent system as well as land ownership of gher farming. It is obvious that farmers of developing countries have faced indecision at the early stages of any agricultural technological progress and innovation for agricultural development (Byerlee, 1996). For example, at the early stage of the green revolution the farmers of Bangladesh were faced with indecision to adopt MV of rice for lack of sufficient knowledge of using chemical fertilizer,

unavailability of irrigation systems, and a changed taste of rice, which played as the main decision-making criteria (Field survey, 2004). But the opposite scenario was found in the case of shrimp/prawn gher farming in Bangladesh.

There are some international organizations and researchers who have conducted research regarding the environmental and ecological aspects of brackish water based on shrimp gher farming. A few organizations and researchers have conducted research on fresh water based rice-prawn gher farming, focusing only on cost-benefit analysis and ecological aspects. However, the problems and prospects of shrimp and rice-prawn gher farming in southwest Bangladesh have been less well studied. Therefore, the present study explains the problems and prospects of shrimp and rice-prawn gher farming in the aforementioned area. The findings of the study are expected to be helpful as benchmark information for economists, researchers, as well as policy makers and will provide useful information for further development of shrimp and rice-prawn gher farming in Bangladesh.

This paper first explains the problems and prospects of shrimp and rice-prawn gher farming system in the southwest Bangladesh. Next, the paper briefly discusses the methodology. Scenario of shrimp/prawn in global and Bangladesh and abroad is briefly discussed, followed by a discussion of the impacts of shrimp and prawn farming in Bangladesh. Advantages of rice-prawn gher farming over shrimp farming in Bangladesh

are delineated in the next and, finally, conclusions are drawn based on the results and discussions.

Methodology of the Study

Primary, secondary and some case studies are used in the present study. Secondary data were collected from various published and unpublished sources of Government and Non-government agencies.

Scenario of Shrimp/Prawn in Bangladesh and Abroad

Global farmed Shrimp and Prawn Production

Shrimp and prawn are commercially produced in 50 countries, which cover an area of more than one million hectares. Moreover, 80 percent of shrimp aquaculture is carried out in the Asian countries. Thailand, China, Indonesia, India, Vietnam and Bangladesh are the major shrimp/prawn producing countries in Asia. The global commercial shrimp/prawn production of 2002 is presented in Table 1.

It is evident from this table that Bangladesh is the fifth largest shrimp/prawn producing country in terms of quantity, whereas in terms of monetary value such cultivation is ranked as the eighth highest in the world. Production of farmed shrimp has grown at the astonishing rate of 20-30% per year in the last decade. There are about 9,000

shrimp farms in Bangladesh, which constitute about 18 percent of the total shrimp farms and 12 percent of the global area under shrimp cultivation (EU, 2002).

Shrimp and Prawn Farming Scenario in Bangladesh

Modes of Shrimp and Prawn Farming in Bangladesh

In Bangladesh, there are two types of gher farming; one is brackish water based shrimp farming and another is fresh water based rice-prawn farming. Shrimp gher farming is large in size and scale, and needs saline water, whereas prawn gher farming is comparatively small in size and scale, and needs fresh water. Traditionally, brackish water based shrimp is cultured in the coastal and peri-coastal regions, and freshwater-based prawn is cultured in the upper areas of Bagerhat, Khulna and Satkhira district. At present there are several production modes of shrimp/prawn in Bangladesh are as follows:

Traditional Shrimp Production

The present shrimp culture involves traditional gher farming method in Bangladesh. In this method, the flow of saline water into the enclosed areas is controlled by small wooden sluice gates.

Table 1: The Top 20 Farmed Shrimp/Prawn Producing Countries by Volume and Value in 2000

Country	Production (M Ton)	Value ('000 US\$)
Thailand	299,700	2,125,384
China	217,994	1,307,964
Indonesia	138,023	847,429
India	52,771	393,938
Vietnam	69,433	319,392
Equador	50,110	300,660
Philippines	41,811	271,385
Bangladesh	58,183	199,901
Mexico	33,480	194,184
Brazil	25,000	175,000
Malaysia	15,895	124,577
Colombia	11,390	91,120
Sri Lanka	6,970	78,342
Taiwan	7,237	60,483
Honduras	8,500	59,500
Venezuela	8,200	34,030
Australia	2,799	27,557
Madagascar	4,800	24,000
Nicaragua	5,411	17,423
USA	2,163	14,513

Source: Ahmed, et al. (2002)

These sluice gates are opened to allow the entry of saline water into the gher from February to April and at that time the juveniles of various varieties of coastal finfish and post larvae of shrimps that breed in the sea enter into the gher with the saline water. These sluice gates are closed after April for the shrimp to grow to harvestable size. Usually the shrimps grow to harvesting size within 4-5 months. In the lower regions of Bagerhat, Khulna and Satkhira districts, the local variety of paddy (*Aman*) is cultivated in the wet months from July-December after the harvesting of shrimp.

Salt Production System

This production system is only practiced in southeastern Cox's Bazar region in Bangladesh. The shrimp and salt are produced successively in the same coastal plots. These plots are used as salt beds during November to April and as shrimp production units during May to December. Salt beds are encircled with low earthen dikes where seawater is brought in, preserved and evaporated during the dry months between November and April. From May to early December salt cannot be produced due to rain and at this time these salt beds are used for brackish water shrimp and finfish culture.

Freshwater Based Rice-Prawn Farming

Rice-prawn gher farming is a new agricultural technique applied to the production of both fisheries and agricultural sector in Bangladesh. This method of prawn production is very popular in southwest Bangladesh (Khulna, Bagerhat, Satkhira, Jessore, and Barisal district) and the people of these areas have more or less adopted this technique.

Gher is the physical construction used for freshwater prawn farming and is a modified rice field having high wide dikes and a canal inside the periphery of the dikes that retains water during the dry season. At the early stage of gher farming most of the farmers cultivated prawn in the ponds, but recently the farmers cultivate fish with prawn. In additions, rice, vegetables and fruit trees are also grown under gher farming system.

The gher cycle begins in May/June when the farmers release prawn post larvae into the gher.

Before this, farmers repair the gher dikes and trenches. This repair work is done almost every year. Farmers use lime during gher preparation to reduce soil acidity. During the growth period, the farmers give supplementary feed to the prawn. Traditionally, only mud snail meat was used as prawn feed, but nowadays farmers use a wide range of homemade and commercial supplementary feeds.

Carp fish fingerlings are released into gher in May/June and cultured for nine months as long as sufficient water is retained in the gher. Usually, no specific supplementary feed is provided for the fish. Fish share the feed supplied to the prawns. The farmers also grow vegetables in the gher during both winter and summer seasons. Some farmers grow vine-type vegetables up trellises inside the gher.

In the gher farming system, farmers usually grow *boro* rice on gher *chatal* (the land inside the gher) during the winter season between January and April. Farmers irrigate the paddy field from the canal using indigenous hand made tools such as *doone*, and basket. Some large farmers use pumps. Sometimes farmers do not irrigate the paddy field. Usually the gher farmers use small amounts of chemical fertilizer for *boro* paddy production. They also use different types of feed in the gher unit during the prawn and carp fish production. But the prawn and carp do not eat all of the supplied feed. The leftover feed fertilizes the paddy field. After harvesting *boro* paddy, the gher is used predominantly for prawn and fish cultivation.

Rapid Expansion of Shrimp/prawn Farming in Bangladesh

Geographically Bangladesh enjoys a series of natural advantages for shrimp/prawn culture. Its soil, water, climate and local cultural heritage are suitable for shrimp/prawn production. Before the shrimp/prawn culture practices that exist today traditional gher aquaculture was practiced only in the coastal belt and offshore areas in southwestern Bangladesh from the 1970s. The commercial shrimp/prawn farming started during the mid 1980s driven by high international market demand.

The trend and/or expansion of shrimp/prawn gher farming is presented in Table 2. The total cultivable

Table 2: Expansion of Shrimp/Prawn Area in Bangladesh from 1983-84 to 2000-02

Year	Khulna Region (ha)	Chittagong Region (ha)	Bangladesh (ha)
1983-84	32,239	19,531	51,812
1984-85	39,976	23,437	64,246
1985-86	62,448	24,781	87,300
1986-87	NA	NA	NA
1987-88	69,053	24,781	94,010
1988-89	80,418	27,514	108,280
1989-90	NA	NA	NA
1990-91	NA	NA	NA
1991-92	NA	NA	NA
1992-93	NA	NA	NA
1993-94	NA	NA	NA
1994-95	104,624	29,792	137,996
1995-96	110,000	30,000	140,000
1996-97	NA	NA	NA
1997-98	NA	NA	NA
1998-99	107,962	29,792	141,353
1999-2000	136,655	30,118	166,377
2000-01	156,290	34,958	196,078

Source: Department of Fisheries, 2003

Note: NA indicates Not Available

land under shrimp/prawn production was 51,812 hectares in 1983-84, whereas the area was 196,078 hectares in 2000-01 out of which about 156,290 hectares (about 80%) of land is situated in greater Khulna region, covering Satkhira, Bagerhat and Khulna districts while only 20 percent (34,958 hectares) is in the Chittagong region. Gher farming has expanded about five times (from about 32,000 hectares to 156,000 hectares) in Khulna region from 1983-84 to 2000-01 but has less than doubled in the Chittagong region (from 19,000 hectares to 34,000 hectares). However, the total gher farming areas have expanded about four times (from about 52,000 hectares to 196,000 hectares) in Bangladesh. The two areas predominately cover the 750 kilometers of coastline in Bangladesh, which is environmentally and geographically favorable for shrimp/prawn aquaculture on a commercial basis (Department of Fisheries, 2003.)

Global Market Structure of Shrimp/Prawn from Bangladesh

Shrimp/prawn production is a 100 percent export-oriented industry in Bangladesh. This industry has

grown gradually over the years due to high demand in international markets. Export of shrimp/prawn from Bangladesh has increased from Tk1,555 million in 1983 to Tk14,477 million in 2001-02 (Table 3). The global market structure of shrimp/prawn from Bangladesh is presented in Figure 1. The figure shows that European Union (EU), USA and Japan are the dominant international markets for Bangladeshi shrimp/prawns. Bangladesh has earned about Tk9,194 million (50.46%) from EU, Tk6,659 million (36.55%) from USA, and Tk1,355 million (7.44%) from Japan by exporting shrimps in 1999-2000.

Importance of Shrimp/Prawn in the Economy of Bangladesh

The economy of Bangladesh mainly depends on the agriculture sector, readymade garments (RMG), fisheries, and hides and skins. Fishery is one of the major sub-sectors, which makes a considerable contribution to the national economy of Bangladesh. Prawn (*Macrobrachium rosenbergii*) and shrimp (*Penaeus monodon*) together represent the second largest exportable items contributing to foreign exchange earnings of Bangladesh. The contribution

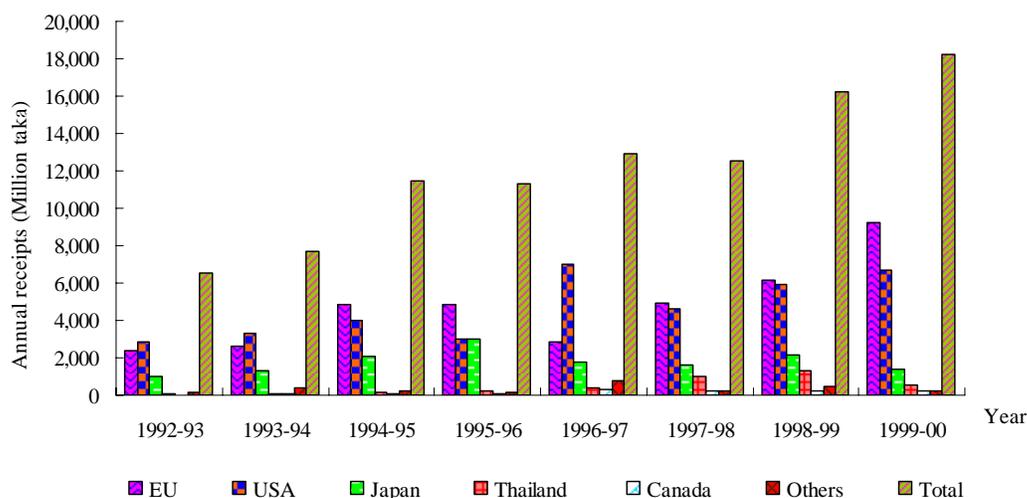


Figure 1: Annual shrimp/prawn export receipts from different countries, 1992-93 to 1999-2000

Source: Annual export receipts, Statistics Department, Bangladesh Bank, 2002.

of this sector is about 4.7% of GDP and 9.38% of the total export (Aftabuzzaman, 1998). This sector grew at the rate of around 9 percent per annum during the last decade (Bhattacharya et al., 1999). Shrimp/prawn has replaced raw jute (so called golden fiber in Bangladesh) as an important export item and contributes nearly half of the export items in the primary goods category.

Total export earning of all exportable products, fish and fisheries products, shrimp/prawn products and their contribution to the national economy are presented in Table 3. The table shows that shrimp/prawn is the most dominant item of the total amount of exported fisheries' products. From the table, it can be seen that the country has earned about Tk144,777 million from shrimp/prawn exports and this accounted for about 88 percent of total national export earning from fish and fisheries products in 2001-02, (table 3) and about 8.84 percent of total national exports (DOF, 2003). The quantity of shrimp/prawn and foreign earning are also presented in figure 2 and shows that the quantity of shrimp/prawn as well as income from exporting shrimp/prawn has increased rapidly over the years. Shrimps and prawn are now called "**white gold**" in Bangladesh.

Shrimp/prawn gher farming has created remarkable employment opportunities and about 10 million people are directly or indirectly employed in a

series of upstream and downstream activities related to shrimp/ prawn culture such as harvesting, culture, processing and exporting (DOF, 2003, Planning commission, 2004, Barmon et al, 2004). The shrimp/prawn industry consists of distinct sub-sectors such as shrimp/prawn gher, shrimp hatcheries or post larvae (PL) collection, feed processing mills and shrimp/prawn processing and exporting plants. All these sub-sectors are linked together and constitute a horizontal integration of activities that create independent employment opportunities for males and females.

Impacts of Shrimp and Prawn Farming in Bangladesh

Environmental and Ecological Impacts

Impacts of Shrimp Farming

A large number of research articles and reports have been published on the impact of shrimp gher farming on the environment in the coastal region of Bangladesh (Rahman et al, 1995; Sobhan 1995; Nijera Kori 1996; Asaduzamman et al, 1998; Habib 1998; Nabi et al 1999; Aftabuzzaman 1998; Rahman 1998; Bhattacharya et al 1999; Toufique 2002; and Chowdhury, et al. 2006). They argue that export-oriented shrimp production has a drastic negative impact on the environment, ecology, society, livestock, agricultural production, man-

Table 3: Total earning from all export products, fish and fisheries products, shrimp/prawn products of Bangladesh, from 1983-84 to 2001-02

Year	Total export earning (Taka, Million)	Total export earning from shrimp/prawn (Taka, Million)	Total export earning from fishery product (Taka, Million)	% of total export earning from fisheries product	% of export earning from shrimp/prawn product	% of fisheries export earning from shrimp/prawn product
1983-84	20,136	1,555.0	1,960.8	9.74	7.72	79.30
84-85	26,225	1,994.5	2,332.5	8.89	7.61	85.50
85-86	27,396	2,693.1	3,562.5	13.00	9.83	75.60
86-87	33,682	3,417.5	4,240.5	12.59	10.15	80.59
87-88	41,161	3,611.7	4,541.2	11.03	8.77	79.53
88-89	42,686	3,820.5	4,787.7	11.22	8.95	79.80
89-90	51,415	4,143.1	4,787.7	9.31	8.06	86.54
90-91	60,272	4,512.2	5,266.2	8.74	7.49	85.68
91-92	74,198	4,557.3	5,243.5	7.07	6.14	86.91
92-93	88,215	6,040.3	7,002.9	7.94	6.85	86.25
93-94	98,739	7,877.3	9,209.6	9.12	7.89	85.83
94-95	136,970	10,456.7	13,069.4	9.54	7.63	80.01
95-96	144,521	11,063.9	13,409.4	9.28	7.66	82.51
96-97	171,554	11,889.1	14,574.1	8.50	6.93	81.58
97-98	229,408	11,814.8	13,878.1	6.05	5.15	85.13
98-99	245,619	11,622.1	13,793.3	5.62	4.73	84.26
99-00	247,420	16,121.5	17,813.2	7.20	6.52	90.50
00-01	324,198	18,851.5	20,327.5	5.77	5.81	92.74
01-02	309,363	14,477.6	16,371.4	4.76	4.68	88.43

Source: DOF, 1995-96, 1996-97, 1998-99 and 2001-2002.

Note: 1US\$=65.85 Taka, November, 2005.

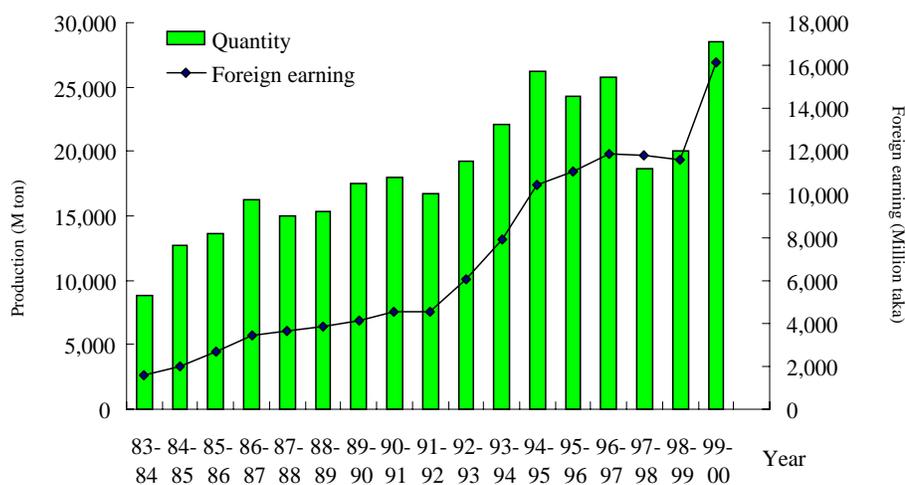


Figure 2: Export of shrimp/prawn and income from exporting of Bangladesh, 1983-84 to 1999-2000

Source: Export Promotion Bureau, BBS, 1999 and 2002.

grove forests as well as human health in Bangladesh. Many of the environmental and ecological problems associated with shrimp farming have also been criticized in India (Alagarwamy 1995; SCI 1996; Patil and Krisnan 1997; Kutty 2001; Ravichandran and Rao 2001). The impact of shrimp gher farming on the environment and ecology of Bangladesh are summarized below:

a. Impact on the Environment

The agricultural land has been degraded since the introduction of shrimp gher farming in Bangladesh. Shrimp gher farming has other negative environmental impacts including mangrove deforestation, salinization of soil and water, depletion of wild shrimp and fish larvae stocks, coastal water pollution and loss of agricultural lands. The salt intrusion has caused many problems such as loss in crop production, fresh water crisis and related gastro-intestinal diseases, loss of green vegetables, fodder etc. More than 30% of the net cultivable land of Bangladesh is located in the coastal areas and are not being utilized for agricultural production mainly because of salinity problems (Wahab, 2003). Paddy yield has also been reduced because of soil salinity problems (Chowdhury et al, 2006).

b. Impact on Ecology

The shrimp gher farming system has also significant negative impacts on the ecology in Bangladesh like in other shrimp production countries. The ecological effect of acid sulphate destroys food resources, displaces biota, releases toxic levels of aluminum, precipitates iron (which smothers vegetation and microhabitat) and alters physical and chemical properties of water. Loss of biodiversity due to shrimp production is also of real concern. Fry is the main input of shrimp gher farming that is collected from the sea and rivers. When the harvesters collect wild post larvae (PL) from seas, a large number of finfish and other fries of fish are caught, most of which perish. Their study found out that about 1,340 other fries are caught during the collection of a single prawn PL (Deb et al, 1994 and Williams and Khan, 2002).

Impacts of Prawn Farming

The rice-prawn gher system has also significant impacts on environment and ecology like shrimp

gher farming system in Bangladesh (Kendrick, 1994; Koori, 1996; Ambary, 2000; Abed in et al 2000; Islam et al 2001; and Boutique 2002). The impacts of rice-prawn gher farming system on environments and ecology are presented below:

Impact on Environment and Ecology

The rice-prawn gher farming system also has a negative impact on the ecology and livestock. Fish diversity and fish catch has decreased in the swamplands, canals and rivers, because of siltation or blockage of fish migration routes, water pollution as well as decreased swampland area due to gher construction (Abedin at et, 2000; and Islam, 2001). They conclude that indigenous fish are disappearing day by day, and some indigenous varieties have already become extinct. Along with indigenous fish, tortoise and frogs are also disappearing. Another study was conducted by Islam et al (2001) and concluded that fish availability is decreasing due to over-fishing of PL.

The main input of prawn production--mud snail--has two direct significant negative impacts on the ecology and human health. People have collected mud snails (*Pila globosa*) intensively from swamplands, canals and rivers to use as feed for prawn production; as a result, the mud snail has already disappeared in greater Khulna district. Now the farmer is importing mud snail from other districts as well as from India. This unplanned intensive harvest of mud snail has a negative impact on the ecology (Kendrick, 1994; Chowdhury, 1999; Datta, 2001; and Islam, 2001). Dutta (2001) suggests that mud snails play an important role in wetland ecosystem and soil chemistry. Williams and Khan (2001) mentioned that the women and children who crush the mud snail for prawn feed suffer from skin irritations and respiratory complaints. In addition, the farmers often dump the shell of mud snails at the edge of roads or in nearby canals thereby polluting the local waterway and sometimes blocking the natural drainage system. However, recently this shell is being used as an input for poultry feed and lime. The grinding process of the shells creates dust that also causes respiratory problems for human health because the grinding mills are mainly located in the residential areas (Barmon, 2006).

Impact of Shrimp and Rice-prawn Gher Farming on Livestock

The impact of rice-prawn gher farming on livestock

is unambiguous. Kendrick (1994), Williams and Islam (1999) and Williams and Khan (2001) argued that livestock has decreased mainly due to unavailability of grazing land and unavailability of fodder crop. On the other hand, Barmon et al (2003) concluded that this farming system has a positive impact on livestock. Livestock and poultry in rice-prawn farming areas have increased compared to shrimp gher farming areas. Before rice-prawn gher farming had started, landlords or rich farmers had a large number of cows, and buffaloes and hired local boys to take care of the cows but most of the small, landless and marginal landowners had no cows or sometimes a few of them. Livestock was not equally distributed among the people. Now, more or less, the people are rearing more than two to three cows for milk and cow-dung. Instead of unavailable grazing fields, the gher farm owners and even landless farmers collect feed (grass) from the embankments and store by-product of paddy (straw) for cattle feed. The farmers use the stored straw in the rainy season when feed is not available.

Economic Impact of Shrimp and Rice-prawn Gher Farming System

a. Impact on Agricultural and Household Income

Both the shrimp and rice-prawn gher farming systems have significant impacts on agricultural and household income in Bangladesh. The average income from shrimp gher farming system is several times higher compared to other agricultural farming systems in Bangladesh. Income from year-round only shrimp and year-round rice-shrimp farming are two times and 2.5 times higher, respectively, than that of year-round rice farming system in coastal Bangladesh (Islam, 2003). However, contradictory results are also found in shrimp gher farming system in the coastal areas of Bangladesh (Rahman, 1996; and Patwary, 2000). The shrimp gher farming system has increased income for rural women in terms of fry collection from the river and sea. It is estimated that about 73% of the income from fry collection come from female fry collectors (BCAS, 2001).

On the other hand, the farmers of rice-prawn gher farming system have gained more agricultural income as well as household income compared to traditional and modern variety (MV) paddy in southwest Bangladesh. The agricultural income of rice-prawn gher farming system is seventeen times

higher than that of MV paddy farming, and the household income of rice-prawn gher farmers is double compared to other rural peoples of Bangladesh (Barmon et al, 2004a, 2004b).

b. Impact on Employment

Both shrimp and rice-prawn gher farming systems have created employment opportunities for female and male worker in southwest Bangladesh. About 840,000 workers were employed in shrimp farm-related work, which was estimated to be about 79 person-days per hectare per year (Frankenberger, 2002). Among them, 285,000 persons were involved in PL collection from the wild (BCAS, 2001).

The rice-prawn gher farming system has created more employment opportunity compared to MV paddy farming both for male and female labors. The rice-prawn gher farming system is a labor intensive enterprise compared to paddy farming. Per unit labor use in gher farming was higher than per unit *boro* and local *aman* paddy production. The income of gher farmers has increased due to a high demand for hired labor in gher farming systems. The gher farming system also plays a pivotal role in absorbing the surplus labor force in the rural areas (Barmon et al, 2004c).

c. Impact on Landholding Patterns and Land Tenurial Systems

The shrimp farming system has significant impacts on landholding patterns and land tenurial system in southwest Bangladesh. Marginal and small farmers are exploited by the politically and financially strong large farmers. Marginal and small farmers have to sell their small agricultural farmland very cheaply. Sometimes the strong farmers capture nearby farmers' small plots without any payments or sometimes they pay a very small amount of money as land rent. As a result, small and marginal farmers are deprived of conventional farming. Therefore, the small and marginal farmers are diminishing from the agricultural sectors mainly due to the introduction of shrimp farming and the involvement of large numbers of so called politicians and large farmers. A large number of small and marginal farmers have already migrated to other places for employment and better living (Field survey, 2005).

The rice-prawn gher farming system has significant

impacts on institutional change in land tenurial arrangement. The land tenurial arrangement has changed from traditional sharecropping to fixed rent system after the introduction of the rice-prawn gher farming system. The rice-prawn gher farming system is a capital intensive enterprise and needs proper management for optimal production to protect from viral diseases, as well as poaching of prawns. Moreover, the landlords and the tenants cannot predict the main output before harvesting. As a result, the land tenurial arrangement has converted from traditional sharecropping system to fixed rent system. The land rent depends on its productivity, distance from the river, and altitude. Land rent has increased over the years because of large scale participation of marginal and landless farmers, as well as profitable enterprises compared to paddy farming.

The landlords mainly engage in non-farm activities and a small portion of their total gher farm operates mainly for home consumption using permanent hired labor. Even though the rice prawn gher farming is a profitable enterprise, landlords do not operate total gher farm because the need for permanent hired labor disrupts prawn production at every step. As a result, the landlords rent out gher farms to marginal and landless farmers on fixed rent agreement basis.

The rice-prawn gher farming system has redistributed the landholding patterns due to the participation of marginal and landless farmers. Some marginal and landless farmers have become small landowners after the successful operation of rice prawn gher farming (Barmon, 2006). The impact of shrimp and rice-prawn gher farming system is presented in Table 4.

Advantages of Rice-Prawn Gher Farming over Shrimp Farming in Bangladesh

The major hurdles that shrimp farming has faced can be overcome by the adoption of freshwater prawn gher farming as an alternative in suitable locations where adequate freshwater is available. Supply and availability of prawn feed is the main constraint for steady production. At the early stages, the farmers mainly used mud snails as prawn feed, which was collected from swampland, canals, and rivers. As mentioned earlier, the continuous harvest of mud snails had a negative impact on the ecology. Now-a-days, the farmers are providing various home-made feed applying

learning-by-doing techniques. As a result, prawn production has had little negative impact on the ecology.

Rice-prawn culture is different from the conventional shrimp farming because of the difference in farm management system and the structure of the production unit. Rice-prawn gher farming is friendlier to the environment compared to shrimp farming. As mentioned earlier, agricultural land has been degraded and agricultural production reduced due to shrimp production in coastal areas in Bangladesh. However, the opposite effects are found in the case of rice-prawn gher farming that offers significant scope economies. The farmers produce mainly two agricultural products-prawn and MV paddy under rice-prawn farming system and the production process within each enterprise have positive externalities. On the one hand, this farming system provides sufficient amounts of rice that can meet local demands. On the macro side, this farming system is earning remarkable amount of foreign currency and contributing significantly to the Gross Domestic Product (GDP).

Moreover, almost all farmers are getting additional fish and vegetables for home consumption from rice-prawn gher farming than is not possible under shrimp farming. The main reason is that freshwater prawn responds well in polyculture with carp and tilapia (Zimmerman and New, 2000; Kurup, Ranjeet and Hari 2002). However, bottom-feeding fish should be kept away from polyculture with prawn production (Reddy, Ramakrishna and Rao 1988; and Kanaujia and Mohanty, 1996).

A large number of marginal and small farmers are engaged in rice-prawn gher farming system renting land from the landlords that is possible for shrimp farming. Landless farmers are also being benefited by rice-prawn gher farming system along with marginal and small farmers.

Conclusions

Shrimp/prawn is the second largest exportable industry in Bangladesh and has significant impacts on the national economy of Bangladesh. Both exportable shrimp and prawn are being produced in the gher farming system. The shrimp farming system has negative impacts on the environment, ecology, land degradation, livestock, and water quality, whereas the rice-prawn gher farming

system is friendlier to the environment, ecology, and water quality. The rice-prawn gher farming system has significant impacts on land fertile for MV paddy production. The yield of MV paddy farming under rice-prawn gher farming system is almost same as the yield in other parts of Bangladesh where the farmers usually produce

only year-round MV paddy. While the rice-prawn gher farming system is providing a sufficient amount of rice that helps meet the local demand for food, it also earns foreign currency that helps to contribute to the gross domestic product (GDP). The policy makers should thus take necessary steps

Table 4: Impacts of Shrimp and Rice-prawn Gher Farming System in Bangladesh

Particulars	Shrimp Gher Farming	Rice-prawn Ghe Farming
Employment status	Decreased	Increased
Income generating	Decreased	Increased
Income distribution	Inequality	Relatively less inequality
Social status	Decreased	Decreased
Livestock	Negative	Positive
Poultry	Negative	Positive
Paddy production	Negative	Positive
Vegetables production	Negative	Positive
Health	Negative	Negative
Ecology	Negative	Negative
Environments	Negative	Friendlier
Land degradation	Negative	Positive
Salinisation	Negative	Positive

Source: Field Survey, 2003, 2004 and 2006.

and implement policy for the development of environmentally and ecologically friendlier rice-prawn in Bangladesh.

REFERENCES

- Abedin, J., Islam, S., Chandra, G., and Q.E. Kabir (2000). Freshwater prawn (*Macrobrachium rosenbergii*) sub-sector study in Bangladesh. Greater options for local development through aquaculture (GOLDA) project, CARE, Bangladesh. Funded by the department for international development, UK.
- Ahmed, S.A., D.L. Mallick, M.L Ali and A.A. Rahman (2002). Literature review on Bangladesh shrimp. Policy Research for Sustainable Shrimp Farming in Asia (PORESSFA): *A comparative analysis of Bangladesh, India, Thailand and Vietnam with particular reference to institutional and socio-economics aspects*. Bangladesh Center for Advanced Studies, Dhaka-1209, Bangladesh.
- Aftabuzzaman, (1998). Sustainable Environment-Friendly aquaculture. In Centre for Policy Dialogue, *Environmental Consequences of Export Oriented Shrimp Culture in Bangladesh*, CPD Dialogue Report No. 18, Centre for Policy Dialogue, Dhaka, Bangladesh.
- Alagarwamy, K. (1995). India-Country Report. In: *FAO/NACA report on a regional study and workshop on the environmental assessment and management of aquaculture development*. NACA environmental series No. 1, pp. 141-186, Network of Aquaculture Centers in Asia-Pacific, Bangkok, Thailand.
- Asaduzamman, M. and K.A. Toufique (1998). Rice and Fish: “Environmental dilemmas of development in Bangladesh” in *Growth or Stagnation? A review of Bangladesh’s Development 1996*, Center for Policy Dialogue, University presses Ltd. Dhaka (mimeo).

- Ansary, M.A.J. (2001). *Compilation of environmental diaries from all thana offices in 2001*. Greater options for local development through aquaculture (GOLDA) project, CARE, Bangladesh. Funded by the department for international development, UK.
- Bangladesh Center for Advanced Studies (BCAS) (2001). 'Fry collectors livelihood study', *Feasibility study for the shrimp component of the fourth fisheries project (FFP)*, The DoF, Bangladesh and DFID, UK, House No, 23, Road No. 10A, Dhanmondi, Dhaka-1209, Bangladesh.
- Barmon, B.K. (2003). *Impact of rice-prawn gher farming on agricultural income in Bangladesh-A Case Study of Khulna District*, Unpublished MS Dissertation, Laboratory of Development Economics, Department of Agricultural Economics, Hokkaido University, Japan.
- Barmon, B.K., Kondo, T., and F. Osanami (2004a). Impacts of Rice-prawn Gher Farming on Cropping Patterns, Land Tenant System, and Household Income in Bangladesh: A Case Study of Khulna District. *Asia-Pacific Journal of Rural Development (APJORD)*. Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP), Vol. 14, No. 1, pp-10-28.
- Barmon, B.K., Kondo, T., and F. Osanami (2004b). Impact of Rice-Prawn Gher Farming on Agricultural and Household Income in Bangladesh: A Case Study of Khulna District. *Journal of Bangladesh Studies (JBS)*. Vol. 6, No. 1& 2, pp.51-61. The Pennsylvania State University, Erie, USA.
- Barmon, B.K., Kondo, T., and F. Osanami (2004). Labor Demand for Rice-Prawn Gher Farming in Bangladesh: A Case Study of Khulna District. *The Review of Agricultural Economics*. Vol. 60, pp. 273-287.
- Barmon, B.K. (2006). *Socio-economic impacts of Rice-prawn gher farming system in Bangladesh*. Unpublished PhD Dissertation, Laboratory of Development Economics, Department of Agricultural Economics, Hokkaido University, Japan.
- Bhattacharya, D., M. Rahman and F. Khatun (1999). Environmental impact of structural adjustment policies: The case export oriented shrimp culture in Bangladesh, *Centre for Policy Dialogue*, and Dhaka.
- Byerlee, D (1996). Modern Varieties, Productivity, and Sustainability: Recent Experience and Emerging Challenges. The World Bank, Washington, DC, USA. *World Development*, Vol. 24, No.4, pp. 697-718.
- Chowdhury, M.H. (1999). *Study on Thana level trading system*. A study report of Greater options for local development through aquaculture (GOLDA) project, CARE, Bangladesh. Funded by the department for international development, UK.
- Chowdhury, M.A., Shivakoti, G., and M. Salequzzaman (2006). A conceptual framework for the sustainability assessment procedures of the shrimp aquaculture industry in Bangladesh, *International Journal of Agricultural Resource, Governance and Ecology*, Vol. 5, No. 2/3, pp. 162-184.
- Datta, D.K. (2001). *Ecological role of fresh water apple snail Pila globosa and the consequences of its over-harvesting from beel ecosystem of Bagerhat and Gopalganj district*. A study report. Study carried out jointly by Khulna University and GOLDA project of CARE Bangladesh. Funded through Department for International Development.
- DOF, (2000, 2001, 2002, 2003). Shrimp Resources Statistics. Central Shrimp Cell, *Department of Fisheries*, Government of Bangladesh, Dhaka.
- Frankenberger, T.R. (2002). *A livelihood analysis of shrimp fry collectors in Bangladesh, future prospects in relation to a wild fry collection Ban*, Tango International Inc, Department of International Development, Dhaka, Bangladesh.
- Habib, E. (1998). "Legal Aspects of Shrimp Cultivation", paper presented at the workshop on environmental impact of structural adjustment policies in Bangladesh organized by the Center for Policy Dialogue, 17 May 1998, Dhaka.
- Islam, S. (2001). *Study on beel fisheries in gher farming areas under Bagerhat district*. Greater options for local development through aquaculture (GOLDA) project, CARE-Bangladesh.
- Islam, M.S. (2003). Socioeconomic impacts of alternate shrimp-shrimp-crop farming in Bangladesh, pp. 61-78, in M.A. Wahab (Ed.)

- (2002) 'Environmental and socioeconomic impacts of shrimp aquaculture in Bangladesh', *Technical proc.* BAU-NORAD Workshop, BRAC Centre, Dhaka, Bangladesh, Bangladesh Agricultural University, Mymensingh, Bangladesh, 5 March, p 101.
- Islam, S., Dutta, G.C., and M. H. Chowdhury (2001). Environmental impact of catching PL (Post Larvae) of Prawn and Shrimp from coastal area. Greater options for local development through aquaculture (GOLDA) project, CARE, Bangladesh. GPO Box No.226, Dhaka 1000.
- Kanaujia, D.R., and A.N. Mohanty (1996): Prospects of both mono and mixed culture of *Macrobrachium Malcolmsonii*, *Fishing Chimes* Vol. 16, pp. 7-9.
- Kendrick, A. (1994). *The Gher Revolution: The Social Impacts of Technological Change in Freshwater Prawn Cultivation in Southern Bangladesh*. The Report of a Social Impact Assessment Prepared for CARE International in Bangladesh with Support from the Bangladesh Aquaculture and Fisheries Resource Unit (BAFRU).
- Kurup, M., Ranjeet, K., and B. Hari (2002): Ecofriendly farming of giant freshwater prawn. *INFOFISH International*, Vol. 5, pp. 48-54.
- Kutty M.N. (2001). Social conflicts in shrimp in coastal aquaculture with special reference to socio-economic impact and sustainable development. In: *Proceeding of the International Workshop on Aquaculture and Environment* (ed. by N.R. Menon, B.M. Kurup and R. Philip), pp. 127-148. Center for Integrated Management of Coastal Zones. Cachin University of Science and Technology, Cochin, in association with the Technical University Delft and Wageningen Agricultural University, The Netherlands and CUSAT, Kochi, India.
- Nabi, S.M.N., G. Sarker., M.A. Alim., and M.T. Islam (1999). The effect of rice cultivation on growth of freshwater prawn (*Macrobrachium rogenbergii*) in gher farming systems. Greater options for local development through aquaculture (GOLDA) project, CARE, Bangladesh, Road No. 7/A, House No. 65, Dhanmondhi, Dhaka-1209.
- Nijera Kori (1996). The impact of shrimp cultivation on soils and environment in Paikgacha region, Khulna (Limited to polders 20, 21, 22, 23, and 24).
- Patwary, M.S.H. (2000). *An assessment of the socio-economic and land use changes due to brackish water shrimp culture-A case study on Jabusha village, Rupsha Thana, Khulna District*, unpublished MS dissertation, Marine Biology Discipline, Khulna University, Khulna, Bangladesh.
- Patil, P.G. and M. Krishnan (1997). The social impacts of shrimp farming in Nellore district, India, *Aquaculture Asia*, Vol. 2, pp. 3-5.
- Rahman, F. (1996). *Socio-economic impact of increasing shrimp culture-A study on Soladana village, Paikghaca Thana, Khulna district*, unpublished MS dissertation, Marine Biology Discipline, Khulna University, Khulna, Bangladesh.
- Rahman, A. et al. (1995). Shrimp culture and environment in the coastal region. Working paper new series no. 8. Bangladesh Institute of Development (BIDS), Dhaka.
- Rahman, M. (1998). Shrimp Culture, Global Compulsions and Policy Options for Environmental Protection. *Centre for Policy Dialogue (CDP)*. Environmental Consequences of Export Oriented Shrimp Culture in Bangladesh: Reforms and Changes. A Workshop Report.
- Ravichandran, P. and Rao, G.R.M (2001). Sustainable brackish water aquaculture. In: *Sustainable Indian Fisheries* (ed. By T.J. Pandian), pp. 134-151, National Academy of Agricultural Sciences, New Delhi, India.
- Reddy, O.R., Ramakrishna, R. and K.G. Rao (1988). Polyculture of *Macrobrachium malcolmsonii* (H. Milne Edwards) and Asiatic Carps. In: *Proceedings of the first Indian Fisheries Forum* (Ed. By M.M. Joseph), pp.21-23. Asian Fisheries Society, Indian Branch, Mangalore, India.
- SCI (1996). Judgment of the supreme court of India in the case related to aquaculture, December, 1996, Supreme Court of India, New Delhi, India, pp. 44.
- Sobhan, A.S. (1997). Bangladesh country paper on shrimp sector. Paper presented at the international training course on pollution control and minimization in small and medium sized marine

food processing industries in the developing countries of South Asia, 28-30 October 1997, Bangkok.

Toufique, K. A. (2002). Community responses to environmental degradation due to shrimp aquaculture in Bangladesh. *Bangladesh Institute of Development Studies (BIDS)*. Paper for presentation in the 9th Biennial Conference of the International Association for the Study of Common Property on the Commons in an age of Globalization to be held in Victoria Falls, Zimbabwe, 17-21 June.

Williams, D., and S. Islam (1999). *Study report on impacts of gher farming on agriculture and livestock*. Greater options for local development through aquaculture (GOLDA) project, CARE-

Bangladesh. Funded by the Department For International Development (DFID), UK.

Williams, D., and N.A. Khan (2001). *Freshwater prawn farming in gher systems: Indigenous technology developed in south-west Bangladesh*. Greater options for local development through aquaculture (GOLDA) project, CARE-Bangladesh, GPO Box No. 226, Dhaka 1000.

Zimmerman S., and New, M.B. (2000): Grow-out system-poly-culture and integrated culture. In: *Freshwater Prawn Culture: The Farming of Macrobrachium rogenbergii* (ed. by M.B. New and W.C. Valenti) pp. 187-202, Blackwell Science, Oxford, UK.

Basanta Kumar Barmon
Postdoctoral Fellow
Laboratory of Development Economics
Department of Agricultural Economics
Graduate School of Agriculture, Hokkaido
University, Japan
E-mail: bkbarmon@yahoo.com

Kondo Takumi
Associate Professor
Laboratory of Development Economics
Department of Agricultural Economics
Graduate School of Agriculture
Hokkaido University, Japan
E-mail: kondot@agecon.agr.hokudai.ac.jp

Fumio Osanami
Professor
Laboratory of Development Economics
Department of Agricultural Economics
Graduate School of Agriculture
Hokkaido University, Japan
E-mail: osanami@agecon.agr.hokudai.ac.jp