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SCIENCE AND TECHNOLOGY DEVELOPMENT IN BANGLADESH: FAILURE IN POLICY IMPLEMENTATION

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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
1st	Public statement	Frequently made statements indicate awareness of the importance of S&T in national development
2nd	Published official statements	Official statement on National Science and Technology Policy made in 1986.
3rd	Statement in planning documents	Commonly found in planning documents and budget speeches.
4th	Enactment of laws to ensure long-term validity, sectoral compliance and departmental cooperation	Explicit science and technology development laws are not available.
5th	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 transplantations 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.

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Commentary

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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 Desh 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, Desh Garments walked away from the agreement to set up its own factories and export business. Some of the supervisors and managers working for Desh 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 pubic 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.

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Commentary

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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 constitution[1].

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 considerably[2]. 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 years[3].

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 1995[4]. 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 intensions 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

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Commentary

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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 simulation of local demand of these goods, S&T will automatically take root in the country as a natural outcome.

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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.

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