9

Bangladesh

Strategizing Communication in Commercialization of Biotech Crops

Khondoker M. Nasiruddin

Bangladesh is on the verge of adopting genetically modified (GM) crops for commercial cultivation and consumption as feed and food. Many laboratories are engaged in tissue culture and molecular characterization of plants, whereas some have started GM research despite shortage of trained manpower, infrastructure, and funding. Nutritionally improved Golden Rice, Bt brinjal, and late blight resistant potato are in contained trial in glasshouses while papaya ringspot virus (PRSV) resistant papaya is under approval process for field trial.

The government has taken initiatives to support GM research which include the establishment of a Biotechnology Department in all relevant institutes, and the formation of an apex body referred to as the National Task Force

COUNTRY PROFILE

The world's largest delta, Bangladesh is a very small country in Asia with only 55,598 square miles of land. It is between India which borders almost two-thirds of the territory, and is bounded by Burma to the east and south and Nepal to the north. Despite being small in size, it is home to nearly 130 million people with a population density of nearly 2000 per square miles, one of the highest in the world. About 85% live in rural villages and 15% in the urban areas. The country is agricultural where 80% of the people depend on this industry. Fertile alluvial soil of the Ganges-Meghna-Brahmaputra delta coupled with high rainfall and easy cultivation favor agricultural development (Choudhury and Islam, 2002). Rice is the staple food while potato, sugarcane, jute, wheat, and corn are other major crops.

Bangladesh is a promising country in South Asia for biotechnology crop commercialization in the near future. It is a party to the Cartagena Protocol on Biosafety and has developed a series of enabling and regulatory frameworks for genetically modified crops management. Research is being done on Golden Rice, Bt brinjal, and blight resistant potato which have gone through glasshouse and two years of field trial.

Committee on Biotechnology of Bangladesh (NTCBB) under the prime minister as chairperson. Biosafety policy guidelines and related aspects of biotechnology issues have been approved and the laws are in the process of being promulgated. Being a party to the Cartagena Protocol on Biosafety, proper biosafety measures are regulated by the appropriate authority as stated. Although there are no laws yet for biosafety of GM crops and food, relevant laws on agriculture, medicine, food, import, trade, and environment may suffice. The second powerful body, the National Executive Committee on Biotechnology of Bangladesh (NECBB) is also functioning under the Principal Secretary to the Prime Minister. Five National Technical Committees (NTC) on Biodiversity, Biosafety, Plant Biotechnology, Animal and Fisheries Biotechnology, and Medical Biotechnology are also operating under the secretaries of the respective ministries. The Task Force approved all guidelines and policies developed by the concerned ministries and NTCs in 2006.

The Ministry of Environment and Forests (MoEF) is the national focal point to implement the Cartagena Protocol on Biosafety to the Convention on Biological Diversity (CBD). It established the National Technical Committee

on Biosafety (NTCB) to ensure environmentally safe management of modern biotechnological development including research and development (R&D), introduction, use, and transboundary movement of living modified organisms (LMOs). They also developed the National Biosafety Framework (NBF) for overall guidance of biotechnological research in the light of biosafety protocols. The Biosafety Core Committee (BCC) assists the NTCB which in turn is supported by the Institutional Biosafety Committee (IBC), Field Level Biosafety Committee (FBC), and Biological Safety Officers (BSO) in each research establishment of the country (Chaturvedi and Srinivas, 2010).

In a circulation released in 2002, the Bangladesh government instructed all research institutes to open Biotechnology and Genetic Engineering Departments. The National Institute of Biotechnology (NIB) was also established. The Ministry of Science and Information and Communication Technology (MOSICT) in the last ten years has continuously provided modest amount of fund for biotech research. Recently, scientists proposed that government set up a separate permanent department in the MOSICT to facilitate biotech activities in the country.

Crop Biotechnology in Bangladesh

Agricultural biotechnology is one option that developing countries like Bangladesh are considering to meet food needs, reduce poverty, and enhance environmental sustainability through improved productivity.

The Department of Botany in Dhaka University started a program on plant biotechnology in the late 1970s with tissue culture of jute. Subsequently, other research institutes and universities such as the Rajshani University, Chittagong University, Jahanirnagar University, Khulna University, Bangladesh Rice Research Institute (BRRI), Bangladesh Jute Research Institute (BJRI), Bangladesh Agricultural Research Institute (BARI), Bangladesh Council of Scientific and Industrial Research (BCSIR), and Bangladesh Institute of Nuclear Agriculture (BINA) also went into tissue culture. They were in addition to non-governmental organizations (NGOs) such as the Development of Biotechnology and Environmental Conservation Center (DEBTECH) and Proshika. Plant tissue culture protocols on plant regeneration and

micropropagation have been developed on different crops, fruit trees, and vegetables and are awaiting commercial use and approval (Choudhury and Islam, 2002).

A limited number of universities and research institutes are doing genetic engineering research, mostly on genetic transformation of jute, pulses, and rice for salinity tolerance and fungus resistance (Choudhury, 2004). Dhaka University, Bangladesh Agricultural University (BAU), Rajshahi University (RU), Bangladesh Sugarcane Research Institute (BSRI), BARI, BRRI, and BINA have started genetic fingerprinting and genetic engineering research. Although facilities are limited, the gene constructs are borrowed and shared with other laboratories from developed countries as part of their collaborative research partnership.

BRRI developed vitamin A-enriched Golden Rice by introgressing the provitamin A genes from a selected GM rice line onto its leading variety BR29, in collaboration with the International Rice Research Institute (IRRI). BRRI received royalty free seeds in 2005 for cultivation in Bangladesh, and completed the second round trial of Golden Rice in its contained facilities. BARI developed fruit and shoot borer resistant Bt brinjal using the Bangladeshi varieties in collaboration with Maharashtra Hybrid Seeds Co. Ltd (Mahyco). Biotech brinjal was subjected to field trial on multi-locations for two years in different BARI research stations under controlled conditions. The scientists' forum and regulatory officials are convinced that it will be released for commercialization in the near term. Bt brinjal will be tested jointly by BARI and East-West Seeds Co. Ltd.

Similarly, the Wisconsin University supplied royalty free potato microtubers cv. Katahdin resistant to late blight disease for subsequent crossing with promising potato cultivars and development of transgenic variety for commercial cultivation. The Hawaii University has shown interest for bilateral cooperation with Bangladesh in providing papaya conferred with resistance against papaya ringspot virus (PRSV). The material transfer is under process and on receipt, BARI and East-West Seed Co. Ltd will jointly evaluate the product under controlled field trial for subsequent commercial release.

National Capacity for Biotechnology and Biosafety

Nasiruddin and Nasim (2007) conducted a national survey to assess national capacity on biotechnology, genetic engineering, and LMOs. The survey revealed that R&D in biotechnology is limited to standardization of plant tissue culture protocols, micropropagation of different commercially important plants, molecular characterization of crop varieties, and embryo transfer in cattle. Many research institutes in the country are engaged in modern biotechnological research and skilled manpower is available. A few scientists were found to have training on biotechnology techniques like gene isolation, cloning, expression characterization, and development of DNA-recombinant vaccines. But infrastructure and other facilities were found inadequate. Biotechnology R&D in fisheries, livestock, medical, and industrial sectors were insignificant.

In general, universities have the greatest number of biotech and related experts followed by research institutes, whereas few can be found in the private sector, NGOs and international initiatives (Appendix 1). Institutes without facilities for biotechnology research have also expressed their intention to start biotech activities in the near future. Universities and research institutes follow biosafety measures as mentioned in the Cartagena Protocol on Biosafety through their Institutional Biosafety Committee (IBC). Universities involved in LMO research are into DNA fingerprinting research; whereas NGO, private, and international initiatives are concentrating on tissue culture propagation of elite genetic materials.

By sector, human capacity in biotechnology, biosafety, and biodiversity varied significantly among the disciplines. Plant sector has the largest number of experts (61.54%), whereas animal and fish (21.37%), and microbial (17.09%) sectors have smaller number of experts. Very few come from the medical and food sectors. Biosafety and biodiversity experts are increasing but very slowly with the development of biotech capacity in the country.

Existing staff members have insufficient training on biotechnology (32.67%), biosafety (16.75%), and biodiversity (18.97%). Updated knowledge on conservation of biodiversity (35.29%), and germplasm characterization (41.18%) were needed by most of the respondents. Most of the Institutes

have limited facilities for toxicological research and labeling (23.08%) and germplasm/characterization facilities (37.04%). However, they are maintaining and using related crops (48.15%) and wild germplasm (50%) for crop improvement. There is negligible number of experts involved in R&D in the areas of biodiversity and biosafety.

The Bangladesh government is very supportive of agricultural biotechnology and more particularly on the development of transgenic crops. Currently, the first batch of crops in the regulatory pipeline include Golden Rice, Bt brinjal (eggplant), and virus resistant potato. Many scientific experts believe that it is high time to raise awareness on biotechnology, transgenic crops, and biosafety regulations. The biotechnology, biosafety, and related acts for handling of LMOs await the formulation process. The approval of regulations for GM food is currently not applied to imports of corn and soybean. There is also a lack of governmental capacity to handle approval and the partial implementation of the biosafety laws (Gruere, 2006).

Biosafety Guidelines and Regulations for GM Crops

In accordance with the precautionary approach contained in Principle 15 of the Rio Declaration on Environment and Development, Bangladesh formulated a Biosafety Guideline for ensuring safety in the laboratory, field trial, safe transfer, handling, use, and transboundary movement of GMOs/LMOs. The National Biosafety Framework (NBF) is also in place to formulate, review, update or amend national policies, guidelines, acts and rules on biosafety and shall supervise risk assessment, risk management, and implementation of activities. Research, development, and promotional or commercialization activities involving organisms within the country that result from natural reproduction or micropropagated products derived through tissue culture or the use of traditional breeding practices do not need any biosafety regulations.

Bangladesh does not have any rules or regulations directly related to GM crops. However, some related laws may address the issues that may arise regarding GM crops. These laws (Huq, 2005) may be related to agricultural production, environment and forests, drugs manufacturing, import

and export, and trade and commerce. Intellectual Property Rights and Farmers' Rights Protection Act were formulated and are in the process of promulgation. The Bangladesh Standards and Testing Institution Ordinance No. 39 of 1985 controls all goods to be marketed or exported with certification mark. The Department of Agricultural Extension (DAE) has a Phytosanitary Laboratory to administer biosafety measures regarding crop sector. Moreover, they have the Seed Act and Seed Certification Agency for import, export, and certification of all crops including transgenics.

Imports and Exports (Control) Act 1950 (SRO No. 35 - Law 1996) under the Principal Order 1997 covers the quality and biosafety of food, beverage, baby food, feed, medicine, biofertilizers, biopesticides, and related products. The container or package should have proper labeling of its contents, origin, radiation and other safety parameters and cautionary indications. The Pure Food Ordinance 1959 (EP Ordinance No. 68 of 1959) also deals with the adulteration, damage or inferiority, food value, nutritive quality, among others, which may render it injurious to health. Analogy in the case of GMOs may be drawn from Article 17 which says that no person shall sell any living thing intended for human consumption which is unwholesome or unfit for use (Ministry of Commerce, 1996). For proper labeling, the Merchandise Marks Act No. IV of 1889 will regulate the false trade description by words or marks. The Agricultural Produce (Grading and Marketing) Act No. I of 1937 is used for grading, quality control, and labeling for agricultural produce like cereals, fruits, vegetables, tobacco, coffee, poultry, and dairy products. Similarly, the Agricultural Produce Markets Regulation Act No. IX of 1964 deals with marketing of products, whereas the Customs Act No. IV of 1969 regulates the clearance including quarantine regulations for transboundary movement of LMOs (Hassan and Rahman, 2004).

The Dangerous Drugs Act 1990 regulates the production, processing, import, export, and transhipment of dangerous drugs, narcotics, and related products harmful to human and animal health (Rahman, 1990). The Department of Environment under the MoEF has provision for testing the environmental biohazards, pollution, toxicity, allergenicity, and assessing environmental impact. The Bangladesh Environment Conservation Act No. 1 of 1995 and the Environmental Conservation Rules 1997 and 2003 have the provision to protect the ecosystem and environmental deterioration from any sort of

living organisms or by import of any such materials. These rules will cover the biosafety of transgenic materials produced in the country or those that come through transboundary movement (Rahman, 1990).

Awareness, Perception, and Adoption Strategy of GM or Biotech Crops

Awareness and extent of knowledge on genetic engineering, biotechnology, and GMOs among the people are relatively low. Bangladesh's National Biosafety Framework (2006) forwards the need to promote and facilitate public awareness, education, and participation concerning the "safe transfer, handling, and use of GMOs in relation to the conservation and sustainable use of biological diversity and risks concerned with human health." It also adds that the public should be consulted regarding decisions about GMOs and biosafety so that the regulatory system is perceived to be transparent and that public acceptance may enhance biotechnological development in the country.

In 2003, the Bangladesh Rural Advancement Committee (BRAC) conducted a survey of the knowledge, attitude, and perception of civil society groups on rice biotechnology research in the country noting that these groups mold public opinion on various national issues. Earlier, IRRI conducted focus group discussions to pilot test the survey questionnaire. Respondents of the BRAC survey were classified into three groups: 1) scientists and research leaders of agricultural research and educational institutions who are expected to be more knowledgeable about the potential risks and benefits of biotechnology and may be its proponents; 2) managers and senior executives of NGOs and environmental advocacy associations who might have been influenced by the on-going debate in the developed countries, and may be the opponents of biotechnology; and 3) other civil society groups who may be least exposed to the debate and may hold a neutral position. Ninety-nine percent of the 232 respondents reported to have heard about biotechnology while 59% said they heard about GMOs. About 86% correctly defined "GMO" as genetically modified organism.

Major sources of information on biotechnology were newspapers (55%), magazines and literature (24%), and television and radio (17%). NGOs were considered a minor information source suggesting that they are yet to play an important role in advocacy. Food safety was a predominant concern as well as socio-economic equity or farmers' access to seeds. Majority supported biotech research and rice, and the import of GMOs given that the food safety and environmental effects are properly assessed and field testing is supervised under proper biosafety regulations. Most of the respondents also supported field testing of genetically engineered iron and vitamin A-enriched rice in the country. The study concluded that civil society is quite aware of biotechnology and GMOs with a fairly good knowledge and understanding of the potential benefits and risks. Although there were not many respondents from NGOs, it was felt that generally, civil society groups were not yet hostile to biotech research and GMOs in the country (Hossain et al., 2004; Husain et al., 2003).

A survey among Bangladeshi scientific experts showed that they were optimistic about the potential of agricultural biotechnology to respond to future biotic and abiotic stresses in the country (Nasiruddin and Nasim, 2007). It was also found that social acceptance of genetic engineering is not considered a major issue, but could become one, and prompted experts to call for a wider awareness campaign on the technology. Choudhury (2004) indicated, however, that public awareness was one key problem that needs to be addressed for Bangladesh to harness the benefits of biotechnology. Other problems identified include biosafety and bioethics, technology transfer and intellectual property rights, and biodiversity.

The 2007 survey also revealed that majority of respondents (63.24%) were of the opinion that GM food is essentially the same as other food because people have been modifying food through conventional breeding and other methods for many years; and modern biotechnology is just a new way of doing the same. However, mixed reaction was observed among the respondents on the safety issues of GM food.

Media and Biotechnology

Media has a persuasive power and influence in Bangladesh and is perceived to have a potent role, among others, to stimulate economic development and shape the country's social, economic, and political life. Print media has seen a phenomenal growth with about 2,100 registered publications of newspapers and periodicals. Television is the most popular media and has the potential to reach the illiterate section of the public which accounts for 50% of the population. Bangladesh Television (BTV), the state-owned national TV channel, has a potential coverage of about 93% of the total population. It aims to motivate people to take part in development activities. Bangladesh Betar is the only radio network in the country and is government-owned. It has a crucial role in "fulfilling some role in changing people's attitude and behavioral patterns and creating mass awareness about the issues that affect them" (Khan, 2008).

Media plays a vital role in spreading biotech messages to the public. Stakeholders are sensitized through print and electronic media towards acceptance of biotech crops. Most of them are made aware of the technology through the print media. Media monitoring of 24 newspapers was done in a 10-year period, 1999-2009 (Nasiruddin and Azzad, 2010). Twenty-four newspapers were monitored: *Prothom Alo, Samakal, Naya Diganta, Daily Star, Bangladesh Observer, New Nation, BD News 24, Jahan, Amar Desh, Ittefaq, Shangram, Krishibiploy, Bangladesh Protidin, Bangladesh Today, Urbara, Amar Khamar Amar Jiban, Farm House, Janakantha, Ajker Kagoj, Bhorer Kagoj, Dainik Bangla, Jai Jai Din, Krishi O Amish, Krishi Katha*. A total of 878 articles on biotechnology were published with an annual average of 88 articles. Articles during the first half of the decade averaged from 49 to 65 per year. There were more articles published between 2005 to 2009, with about 109 articles per year. Articles were predominantly positive (68%) to neutral (16%) in tone, while negative articles accounted for the remaining 16% (Figure 1).

The prominence of articles on biotechnology depends on various factors and events. The media became vibrant in 1999 when the National Biosafety Guidelines of Bangladesh was first gazetted by the Ministry of Science and Technology (MOST). In 2002-2003, the Food and Agriculture Organization (FAO) funded a biotechnology inventory project. Moreover, as a party in the

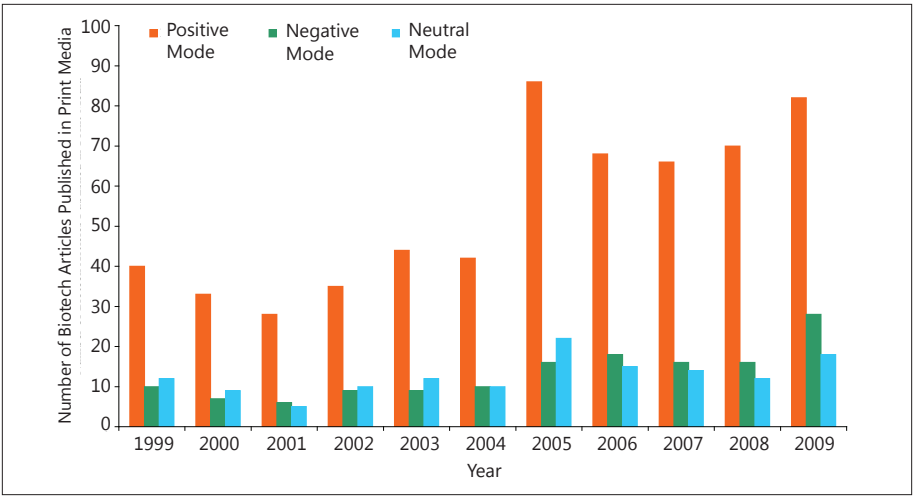

Figure 1. Number of biotechnology and related articles by mode published in newspapers from 1999-2009

initiative by the government, the Principal Secretary to the Prime Minister directed all public universities and research institutes to open Biotechnology and Genetic Engineering Departments. The biotech issue came into public knowledge through the tri-media particularly in 2005 when Agricultural Biotechnology Support Project II (ABSPII), South Asia Biosafety Program (SABP), and the International Service for the Acquisition of Agri-biotech Applications (ISAAA) started their respective knowledge sharing initiatives to sensitize the public. Moreover, as a part of the government initiative, the agriculture minister brought home Golden Rice seeds from his visit to IRRI. Afterwards, the mass media became more active in publishing articles on biotechnology.

Institutions Involved in Strengthening Biotech Awareness and Acceptance

Major agricultural research institutions through their regional stations or sub-stations and universities (Bangladesh Agricultural University, Sher-e-Bangla Agricultural University (BAU), Bangabandhu Shiekh Mujibur

Rahman Agricultural University, and Hajee Mohammad Danesh Science and Technology University) have mechanisms that allow dialogue between scientists and the public on R&D activities regarding GMOs as well as outreach programs and information dissemination activities. Other government departments have information disclosure through the distribution of printed materials (e.g., agricultural magazines, posters, bulletins, booklets, and leaflets), and demonstrations in farmers' fields. The NBF proposes that the Department of Environment takes the lead in managing information related to biosafety using the DAE tier system of information dissemination to farmers as well as mechanisms being utilized by other ministries (Commerce, Food, Health and Family Welfare) to generate, assemble, and disseminate information on GMOs.

Major actors collaborating with government institutions in an effort to increase awareness and understanding of biotechnology in the country include ABSPII, South Asia Biosafety Program (SABP), and the Bangladesh Biotechnology Information Center (BdBIC).

Agriculture Biotechnology Support Project II

This second phase of the USAID-initiated program started in 2002 in Bangladesh. The project is sensitizing people on biotechnology through local and foreign seminars, workshops, and trainings. It is also facilitating research and trial of GM crops in Bangladesh. Under the initiative of ABSPII, Bt brinjal and Rb potato were introduced in Bangladesh in 2006 and are now in contained research and field trials. ABSPII is collaborating with SABP and ISAAA to promote biotech activities in the country. It works closely with policy planners, government organizations, NGOs, and the private sector.

South Asia Biosafety Program

SABP assists the Government of Bangladesh in strengthening institutional governance of biotechnology through public and private consultations, collaborations with ministries of agriculture, health, science and environment; district governments; national research and policy institutions; stakeholders in the agricultural sector; NGOs, farmer groups; and other development agencies. SABP is a collaboration between the Center for Environmental

Risk Assessment (CERA) and the International Food Policy Research Institute (IFPRI). SABP and country partners:

- identify and respond to technical training needs for food, feed, and environmental safety assessment;
- develop a sustainable network of trained, authoritative local experts to communicate both the benefits and the concerns associated with new agricultural biotechnologies to farmers and other stakeholder groups;
- facilitate systems for permitting the safe conduct of experimental field trials of new crops developed using biotechnology so that scientists and farmers can evaluate them; and
- raise the profile of biotechnology and biosafety on the policy agenda and address policy issues within the overall context of economic and agricultural development, international trade, and environmental sustainability.

Activities conducted include workshops on safety assessment of foods derived from genetically engineered crops, compliance management for confined field trials of GM plants, and awareness building on agricultural biotechnology and biosafety. Workshops on awareness building were organized by the BARC and SABP to raise awareness among extension officers from DAE of the potential benefits of biotechnology for Bangladesh agriculture (CERA website).

Bangladesh Biotechnology Information Center

Part of the information network of ISAAA is the Bangladesh Biotechnology Information Center or BdBIC. It was established in February 2005 and is currently hosted by the Department of Biotechnology, BAU in Mymensingh. Through translation into Bangla and repackaging of ISAAA publications such as the *Crop Biotech Update*, Pocket K series on biotechnology and related topics, as well as highlights of the Global Status Review of Biotech or GM Crops, the BdBIC is able to share science-based information to stakeholders who would otherwise, be constrained by the language barrier.

BdBIC also disseminates information through its e-group composed of biotech players in the country such as scientists, government and private sector representatives as well as media. Media workshops in collaboration

Biotechnology workshops enable policy makers to be updated on the technology.

Researcher demonstrates use of PCR during training with agricultural extension workers.

with the National Press Club is an important activity to provide writers and broadcasters with updated information and story leads. Workshops and seminars are also held to brief scientists and other stakeholders on crop biotechnology developments both at a global and country scale. Specific topics include transgenic crops in alleviating hunger and malnutrition, and biosafety and field trial requirements of transgenic crops. To widen awareness and understanding of biotechnology, BdBIC organizes writing competitions on biotech crops in collaboration with BAU. Participants include students, government officials, academics, and scientists.

BdBIC takes an active role in drafting documents on policies and guidelines in cooperation with organizations and government institutions such as MoEF, MOST, and MOA. A significant involvement was to provide information for the national biosafety implementation framework and guidelines for the country. It drafted biotechnology recommendations for the agriculture minister who

participated in the ministerial meeting of the National Technical Committee on Crop Biotechnology for field trial approval of Bt brinjal.

Lessons Learned

Many lessons were gained in the process of communicating crop biotechnology in Bangladesh. Most of the journalists, NGO personnel, and environmentalists were initially unaware about biotechnology. Through the collaborative efforts of both government and private sectors and initiatives by ABSPII, SABP, and ISAAA, stakeholders were sensitized and made aware of the technology's benefits.

A major learning was the need to focus attention on specific stakeholders to engage them in science communication efforts so that they in turn become partners in the process. Efforts to reach out to journalists make it easy to communicate with them so that they can better disseminate accurate information to the public. Journalists' attendance in workshops, trainings, and meetings enhanced the public understanding of the technology and assured regular media placements. Arranged visits for policy planners to different R&D projects equipped them with facts that help them make crucial decisions.

Biotechnology needs to be introduced in the syllabus of school and pre-university levels. This will enable faculty and students to be updated on information that will make them more concerned and responsible citizens. They can be conduits to explain concepts and issues better to consumers within their sphere of influence. Initiatives must be taken to build capacity of scientists and other personnel who can be provided skills to better communicate with the general public.

Availability of user-friendly publications needs to be assured to continuously provide information needs to different audiences. From the conventional communication approaches, it is time to also explore educational and promotional materials using the Internet to facilitate awareness building particularly among the younger generation.

Summary

The overall situation for biotechnology in Bangladesh is favorable. Generally, the country has a pro-biotechnology attitude at the individual to government levels. Unlike other developing countries, there is not much opposition to the technology especially from civil society groups. This has enabled a few GM crops to undergo field trial. However, acts, laws, regulations, and ordinances need to be promulgated to address issues and concerns regarding GMOs and facilitate their adoption. Bangladesh needs human resource and infrastructure development to conduct more efficiently research on biotechnology and biosafety.

Initiatives at increasing awareness and understanding of biotechnology are on-going with less pressure. Public opinion is supportive of the commercialization of biotech crops and, thus, augers well for the growth of biotechnology in the country.

References

Center for Environmental Risk Assessment (CERA). 2010. South Asia Biosafety Program (SABP). http://cera-gmc.org/index.php?action=s._asia_biosafety_program (Accessed October 21, 2010).

Chaturvedi, Sachin and Krishna Ravi Srinivas. 2010. Survey on Biotechnology Capacity in Asia-Pacific: Opportunities for National Initiatives and Regional Cooperation. A Report Prepared for UNESCO, Jakarta. Research and Information System for Developing Countries, New Delhi, India. 108 pp. http://www.ris.org.in/Biotechnology%20Capacity%20in%20Asia-Pacific.pdf (Accessed October 21, 2010).

Choudhury, Naiyyum. 2004. Policy and Development of Biotechnology: Bangladesh Perspective. Asian Biotechnology and Development Review. Research and Information System for Developing Countries. New Delhi, India. pp. 43-73. http://www.ris.org.in/abdr_July045.pdf (Accessed October 15, 2010).

Choudhury, Naiyyum and M. Serajul Islam. 2002. Biotechnology in Bangladesh. Research and Information System for Developing Countries. New Delhi, India. pp. 39-59. http://www.ris.org.in/abdr_nov4.pdf (Accessed October 15, 2010).

Gruere, Guillaume, Imdadul Hoque, Rowena Valmonte-Santos, and Mark Rosegrant. 2006. Potential of Transgenic Crops in Bangladesh: Findings from a Consultation of

Bangladeshi Scientific Experts. Plant Cell, Tissue and Organ Culture. Vol. 86, No. 3: 411-415.

Hassan, S.R. and M. Rahman. 2004. Environmental Laws of Bangladesh. Asha Publishers. Dhaka, Bangladesh.

Hossain, Mahabub, Muazzam Husain, and S. K. Datta. 2004. Rice Biotechnology: Opportunity, Perceived Risks and Potential Benefits to Bangladesh. CPD Occasional Paper Series. Center for Policy Dialogue. Dhaka, Bangladesh. 32 pp. http://www.cpd-bangladesh.org/publications/op/op37.pdf (Accessed October 21, 2010).

Huq, M.E. 2005. Compilation of Environmental Laws. Bangladesh Environmental Management Project. Department of Energy, Dhaka, Bangladesh.

Husain, Muazzam, Manil Bose, and Mahabub Hossain. 2003. Knowledge, Attitude, and Perceptions of Bangladesh Civil Society on Rice Biotechnology Research. RED Reports 2003. BRAC University, Dhaka, Bangladesh and International Rice Research Institute, Los Baños, Laguna, Philippines. 11 pp. http://www.bracresearch.org/reports/knowledge_attitude_and_perceptions_ofcivil_society_on_rice_biotech_research_pdf.pdf (Accessed October 21, 2010).

Khan, Amanullah. 2008. Communication Scenes: Bangladesh. *In* Asian Communication Handbook 2008. Edited by I. Banerjee and S. Logan. Asian Media Information and Communication Center and Nanyang Technological University, Singapore. pp. 101-132.

Ministry of Commerce. 1996. Import Principle Order 1997. *Bangladesh Gazette*. Bangladesh Forms & Publications, BG Press, Dhaka, Bangladesh.

Nasiruddin, Khondoker, and M.A.K. Azad. 2010. Ten Years of Biotech Communication in Bangladesh Print Media. Naya Diganta, Dhaka, Bangladesh.

Nasiruddin, Khondoker and Anwar Nasim. 2007. Development of Agri-biotechnology and Biosafety Regulation Used to Assess Safety of Genetically Modified Crops in Bangladesh. Journal of AOAC International. Vol. 90, No. 5: 1508-12.

National Biosafety Framework of the Government of the People's Republic of Bangladesh. 2006. Department of Environment, Ministry of Environment and Forest. http://www.nib.org.bd/pad/National%20Biosafety%20Framework.pdf (Accessed on October 21, 2010).

Rahman, M.H. 1990. Dangerous Drug Act 1990. Momin Book House. Bangla Bazar, Dhaka, Bangladesh.

Appendix Table 1. Institutional capabilities in public research institutes/ organizations/departments, Bangladesh

Institute/ Organization	No. of Biotech Experts (PhD + MS)	No. Biotech R&D Projects (Ended + Running)	Any Plan for Biotech Research	Any Biosafety Measure Documented-Authority	Future Capacity Building Area
BARI	5+5			yes - IBC	LMO, Trial
BCSIR	3+7			yes - IBC	LMO, Microbial
BFRI	1+0	1+1		yes - IBC	DF
BINA	6+0	1+3		yes - IBC	LMO
BJRI	2+1			yes - IBC	LMO
BLRI	1+4			yes - IBC	
BRRI	5+1			yes - IBC	LMO, Trial
BSRI	1+1	2+1		yes - IBC	LMO
BTRI	0+1				TC
DAE	0+1		yes		TC, Mushroom
DLS	1+1		yes		
DoE					Biosafety
FRI	1+0		yes	yes - IBC	TC
NH					TC, DF
NIB	1+7		yes	yes - IBC	All biotech sectors
WRC	1+0		yes	yes - IBC	TC, LMO
NICVD	1+0		yes		Medical biotech

Appendix Table 2. Institutional capabilities in public/private educational institutes, Bangladesh

Institute/ Organization	No. of Biotech Experts (PhD + MS)	No. Biotech R&D Projects (Ended + Running)	Any Plan for Biotech Research	Any Biosafety Measure Documented-Authority	Future Capacity Building Area
BAU	42+6	9+13	*yes*	yes - IBC	LMO, DF, Biosafety
BSMRAU	4+1		yes	yes - IBC	LMO, DF
CUVAS	1+3		yes		DF
CU	5+5		*yes*	yes - IBC	LMO, DF
DU	16+10		yes	yes - IBC	LMO, DF, Biosafety
JU	4+1		*yes*		LMO, DF
KU	2+5		*yes*	yes - IBC	LMO, DF
RU	12+4		*yes*	yes - IBC	LMO, DF, Biosafety
SAU	2+3		*yes*		LMO, DF
SUST	1+5		yes		LMO
SVC	1+4		yes		TC
BSMMU	0+1		yes		MB, Biosafety
GB	1+3		yes		LMO
BRACU	4+2		yes		LMO
UODA	1+4		yes		LMO

Appendix Table 3. Institutional capabilities in the private sector, NGOs/ international initiatives, Bangladesh

Institute/ Organization	No. of- Biotech Experts PhD + MS	No. Biotech R&D Projects (Ended + Running)	Any Plan for Biotech Research	Any Biosafety Measures Documented- Authority	Future Capacity Building Area
BRAC	1+6				TC
BBL	1+2	0+0			TC
Biotech Intl	0+1				TC
Biotech Seeds	1+2				TC
DEBTEC	1+1				TC
Freelance	1+1				
Proshika	1+3				TC
Square Biotech	0+2				TC
ICDDR'B	1+0				MB, microbial
IUCN	0+1				Biosafety/ Biodiversity
BELA	0+1				Biosafety Law
Bangladesh Medical	0+1				MB

Acronyms:

IUCN - International Union for the Conservation of Nature
BCSIR - Bangladesh Council of Scientific and Industrial Research
BRAC - Bangladesh Rural Advancement Committee
BAU - Bangladesh Agricultural University
BBL - Biotech Bangladesh Limited (Alpha Agro Ltd.)
BSMMU - Bangabandhu Sheikh Mujib Medical University
BELA - Bangladesh Environmental Lawyers Association
BFRI - Bangladesh Fisheries Research Institute
BINA - Bangladesh Institute of Nuclear Agriculture
BJRI - Bangladesh Jute Research Institute
BLRI - Bangladesh Livestock Research Institute
BRRI - Bangladesh Rice Research Institute
BSMRAU - Bangabandhu Sheikh Mujibur Rahman Agricultural University
BSRI - Bangladesh Sugarcane Research Institute
BTRI - Bangladesh Tea Research Institute
CU - Chittagong University
CUVAS - Chittagong University of Veterinary and Animal Science
DAE - Department of Agriculture Extension
DLS - Directorate of Livestock Services

DOE - Department of Environment
DU - Dhaka University
FRI - Forest Research Institute
GB - Gono Bishyavidyalaya
ICDDR - International Center for Diarrheal Disease Research
JU - Jahangirnagar University
KU - Khulna University
NH - National Herbarium
NIB - National Institute of Biotechnology
NICVD - National Institute of Cardio Vascular Diseases
BRACU - BRAC University
RU - Rajshahi University
SAU - Sher-E-Bangla Agricultural University
SUST - Shahajalal University of Science and Technology
SVC - Sylhet Veterinary College
UODA - University of Development Alternative
WRC - Wheat Research Center

Abbreviations

LMO - Living modified organism
DF - DNA fingerprinting
TC - Tissue culture
MB - Molecular biology