BANGLADESH AGRICULTURE

Volume 3 Number 1 January 2010

BAAG 1993

JOURNAL OF BANGLADESH ACADEMY OF AGRICULTURE

EXECUTIVE COUNCIL OF
BANGLADESH ACADEMY OF AGRICULTURE (BAAG)
(2009-2011)

1.	Dr. Kazi M. Badruddoza	President
2.	Dr. M. Golam Ali Fakir	Vice- President
3.	Dr. M. Gul Hossain	General Secretary
4.	Dr. M. Anwarul Quader Shaikh	Treasurer
5.	Dr. S.M. Hasanuzzaman	Member
6.	Dr. M. H. Mondal	Member
7.	Dr. M. Ameerul Islam	Member
8.	Dr. M. Motlubor Rahman	Member
9.	Dr. M. Shamsul. Alam	Member
10.	Professor Lutfur Rahman	Member
11.	Mr. Farid Uddin Ahmed	Member
12.	Professor A. M. M. Tareque	Member
13.	Dr. M. Shahidul Islam	Member
14.	Dr. M. A. Razzaque	Member
15.	Mr. M. Enamul Hoque	Member

EXECUTIVE COUNCIL OF
BANGLADESH ACADEMY OF AGRICULTURE (BAAG)
(2007-2009)

1.	Dr. Kazi M. Badruddoza	President
2.	Dr. M. Golam Ali Fakir	Vice- President
3.	Dr. M. Gul Hossain	General Secretary
4.	Dr. M. Anwarul Quader Shaikh	Treasurer
5.	Dr. S.M. Hasanuzzaman	Member
6.	Dr. M. Ameerul Islam	Member
7.	Dr. M. Motlubor Rahman	Member
8.	Dr. M. H. Mondal	Member
9.	Mr. M. Enamul Hoque	Member
10.	Dr. M. Shahidul Islam	Member
11.	Dr. M. A. Mazid	Member
12.	Dr. Jahangir Alam	Member
13.	Mr. Farid Uddin Ahmed	Member

BANGLADESH AGRICULTURE

Volume 3 Number 1 January 2010

BAAG 1993

JOURNAL OF BANGLADESH ACADEMY OF AGRICULTURE

Published by : Bangladesh Academy of Agriculture, 3-C, Centre Point Concord (3rd Floor),
14 A & 31 A Tejkunipara, Airport Road, Farmgate, Dhaka-1215
Tel : 8115204, E-mail : bkazi@dhaka.agni.com

ISBN : 984 - 31 - 1511 - 6

Subscription Rate :

	Individual		Institution	
Annual	Tk. 200	US $ 30	Tk. 300	US $ 40
Single Copy	Tk. 100	US $ 15	Tk. 150	US $ 20

All communications should be addressed to :

The Editor
Bangladesh Academy of Agriculture
C/O: Dr. Kazi M. Badruddoza
Scientist Emeritus, NARS-B
BARC, Airport Road, Farmgate, Dhaka-1215
Tel : 8115204, E-mail : bkazi@dhaka.agni.com

Printed by :
Bangladesh Academy of Agriculture

BANGLADESH AGRICULTURE

Volume 3 **Number: 1** **January 2010**

Table of Contents

Subject	Page
1. Supply and Management of Agricultural Input: Problems and Issues. By - M. M. Rahman	1-13
2. Supply and Availability of Fertilizers as well as Soil Fertility Status and Its Management in Bangladesh. M. S. Islam	14-41
3. Strategic Decisions in Transformaing Subsistence to Commercial Agriculture in Bangladesh. By - M. Hassanullah	42-54
4. Human Follies for Progress and the Endangered Environment: Pointers to the Policy Planners By -Kazi M. Badruddoza and F. M. Maniruzzaman	55-60
5. কৃষি উন্নয়নে বায়োটেকনোলজির ব্যবহার ও ঝুঁকি By - নীলুফার ইয়াসমিন শেখ	61-70
6. A Citation for Dr. Kazi M. Badruddoza for life-long Contribution to Agricultural Research and Development.	71-77
7. BAAG and Its Activities.	78-84

General Instructions for Preparation of Manuscript

Articles dealing with the past activities, present status and future guidelines in one or more disciplines of agriculture will get priority for publication in this journal. Original research work, both fundamental and applied, will also receive priority. The articles, in addition to being on research results, should preferably be on policy, management, advancement and frontier issues of research, extension and economic aspects on different disciplines/ subjects related to agriculture. The disciplines/ subjects would encompass all sub-sectors of broad-sense agriculture i.e, crops, fisheries, livestock, forestry, environment, economics etc.

The topics may also entail current and future scenarios for improvement of sustainability of the fragile eco-system, food security, natural resource management, input distribution & management, nutrition, agribusiness, climatic risk management, human resource development and economic implications of rapid globalization obtaining since the recent past. The retrospect's and prospects of agricultural improvement vis-à-vis the constraints hindering progress of agricultural development are burning topics needing elaborate analysis and synthesis for the policy markers, teachers, researches, extensonists, service providers, marketing agents, NGOs and private sector entrepreneurs, will also get preference.

The authors are to note the following instructions.

1. Typing the manuscript: Manuscript should be typed in double spacing on A4 size papers leaving at least 2.5 cm in all sides. The text and tables may be typed in 10 points and 4 or 6 point type, respectively on one side of the page only. The full-length articles ordinarily may not exceed 10 typed pages including Tables, Figurers and References.

2. Title of the article: The title should be short, specific and informative. There may not be any scientific name in the title unless it is absolutely necessary, a running (short) title with maximum of 40 characters should be typed at the top of each page.

3. Name of the author(s) and of the institution (s) should be written as under:

a) in case of one or more authors working in the same institution as

M. Ziaul Karim, Department of Agronomy, Bangladesh Agricultural University Mymensigh

b) In case of more than one author working in different places as M. Ziaul Karim, Department of Agronomy, Bangladesh Agricultural University, Mymensigh and Ahmed U. Sarker, Bangladesh Jute Research Institute, Dhaka.

4. Abstract: The abstract should be completely self-explanatory in a single paragraph summarizing the objective, method(s), contents and conclusion of the topic. It should be typed in italic font.

General Instructions for Preparation of Manuscript

5. Original research based full-length article may have the following main headings: Introduction, Materials and Methods, Results and Discussion followed by a Conclusion. If possible, Review- based articles should be described under necessary headings and sub-headings with comments on each and every important item of discussion.

6) Tables: Each table with a descriptive title should be typed in a separate page. The tables are to be numbered as they are placed in the body of the text.

7) Figures and Photographs: Drawing diagrams, graphs etc. should be made in India ink on tracing paper in a form ready for plating. Photographs should be printed in black and white on glossy papers. On the back of each illustration write in soft pencil the number of figure, name(s) of the author(s) and short title of the articles. Magnified drawings and photographs may either show bar scale or numerical magnification. Grouped photographs and drawing should comprise a symmetrical rectangle or square.

8) Literature citation: In the text citation should be made consistently following the " Name and Year Systems" as Shaikh (1998) or (Shaikh,1998) in case of single author, Alam and Miah (1997)in case of two authors or Rahman et al., (1996) in case of three or more authors.

List literature citations, references or bibliography at the end of the paper in alphabetical order. Examples:

- Ahmed S.S. 1997, Cytogenetics of the jute, Bangladesh Jute Fibre Res.10(2): 107-110.
- Ali, M.S., S.A. Khan and A.R. Chowdhury, 1998. Production of rice in the changing climatic condition of Bangladesh. Bangladesh Agriculture: I(1): 9-13.
- BARC, 1995. Fibre Crops of Bangladesh, Bangladesh Agric. Res. Council, Dhaka.
- Khan A.A.1958, Production of rice without irrigation. In: M.A Ali, Bangladesh Agric. Res Council, Dhaka. Pp 217-241.
- Rahman, S.1987. Water stress in potato. In: Annual Report, Bangladesh Agric, Res. Institute, Gazipur, Pp. 170-190.

Editor

- **Two hard copies and a soft copy should be submitted.**

Supply and Management of Agricultural Input: Problems and Issues

M. M. Rahman [1]

Abstract

The major problems and issues of agricultural input supply and management have been discussed in this paper. The discussion is limited to seed, fertilizer, irrigation and pesticides. Production, import, distribution and the related problems, with particular emphasis on input quality (seed, fertilizer and pesticides) and management in the public and the private sector are highlighted. Them important issues relating to quality seed, fertilizer, irrigation and pesticides; and how these issues are affecting production are given special attention in the discussion.

1.0 Introduction

1.1 Inputs combined with good crop management practices are the main yield contributing factors for increasing agricultural production. There is a general notion that if HYV or hybrid variety is used in place of local variety, crop yield will automatically increase. This idea is pervaded among common people and many of the administrators and policy makers. In plant breeding science, there is a term called "Expressivity" which means that a gene can fully express itself, only if proper environment is provided. The proper environment of a high yielding gene is the combination of good quality seeds, proper dosage of fertilizers, optimum use of water and good crop management practices, including pest and disease control. If this environment is not provided, the high yield gene will not express itself to produce yield higher than that of the local varieties. It may even produce lower yield than the local varieties. It is difficult to judge whether this is fully recognized by the policy makers and administrators.

1.2 It has been demonstrated many times that yield of HYVs could be increased to 6-7 metric tons/ha even in the farmers' field with proper use of inputs and improved crop management practices. Alam, (2009) has shown in his studies that yield of Boro rice/ha can be increased to 6-7 tons/ha only by improving on-farm water management. He has also shown that if the irrigation efficiency is increased from the current 35% to 42.5%, Boro rice production will increase up to 21.5 million metric tons

*Former Regional Director of ISNAR for Asia and Pacific and Former Executive Chairman, BARC

against the present production of 17.5 million metric tons; and the present per ha yield of 3.5 tons of Boro rice could be increased to 4.5 tons/ha in the short run and to 6.0 tons/ha in the long run. The average yield/ha of HYV Aus, T. Aman and Boro rice achieved in 2008-09 were 2.41 metric tons, 2.55 metric tons and 3.64 metric tons respectively. The average yield of hybrid rice in Boro season was reported to be 4.59/ha which is questionable according to some people. In 2009, some hybrid varieties were found to be highly susceptible to pests and diseases. It was the result of improper use of inputs as explained by field extension staff. These facts clearly show that inputs are the deciding factors for achieving the desired level of HYV yield.

2.0 Input Supply and Management

2.1 Input supply has relatively improved in recent years, but its management remains a problem. Input supply and management is done by both the public and the private sectors under the policy guidance of the Government. Public sector organizations include: (i) Bangladesh Agricultural Development Corporation (BADC), (ii) Department of Agricultural Extension (DAE), (iii) Agricultural Research Institutes (ARI), (iv) Water Development Board, (v) Local Government Engineering Department (LGED), (vi) Borendra Multipurpose Development Authority (BMDA), (vii) Seed Certification Agency (SCA), and (viii) Bangladesh Chemical Industries Corporation (BCIC). Private sector and NGOs are equally important suppliers of seeds, fertilizers, irrigation equipment and pesticides.

3.0 Seed

3.1 The demand for quality seeds, particularly of HYVs has increased significantly not only for cereals but also for other crops. The demand for hybrid seeds of maize and vegetables has also increased. Hybrid rice varieties are recent entries. It may take sometime to judge the degree of their acceptability. The demand for quality seeds is so high that the public and the private sectors together have not been able to meet the requirements. The gap between demand and supply is still wide.

3.2 ***Seed requirements and supply:*** The requirements of rice, wheat and maize seeds in 2008-09 were 234625, 60000 and 6250 metric tons respectively. BADC supplied 54,379 (23%) metric tons of rice, 19,971 (33%) metric tons of wheat, 83 (2%) metric tons, of maize, and only 0.32% of hybrid rice seeds. The remaining part of the requirements of about 8,000 metric tons of hybrid rice seeds was supplied by the private seed companies (Supreme Seed 2,000-2,500 MT and BRAC, ACI, East West Seeds and others 600 MT to 1000 MT each) mainly through imports. In the same year, BADC provided only 2-5% of the seed requirements of other

crops (potato, jute, pulses and oil seeds, vegetables and spices). On average, BADC provided about 20% of the requirements of cereal seeds. DAE's farmer-based Seed Project ("Production, Storage and Supply of Improved Seeds of Rice, Wheat and Jute at Farmers Level") provided 56,518 MT (19%) of rice and wheat seeds. This means that BADC and DAE together provided about 40% of cereal seeds. Private sector/NGOs provided about 23,300 MT (6%) in 2007-08. More than 50% of seed requirements of cereals are still met from farmers own source. Farmers and private seed companies are also the main sources of seeds of other crops.

3.3 An encouraging development is the production and storage of seeds by farmers through DAE's Seed Project. The project works through block demonstration. Each block consists of 1-3 farmers. The farmers are given seed production training, and the blocks are used as practical demonstration sites. According to SCA and the findings of this study, some of the farmers under the project produce excellent quality seeds. These farmers are selected by private companies as their contract growers. Many companies buy seeds directly from them.

3.4 However, the Seed Project of DAE faces a number of problems. Seed producing farmers are scattered and spread over a larger area, which makes it difficult to closely supervise and manage the project with Farmer to farmer seed exchange consumes only a small part of the seeds produced under the project; the major part is sold in the open market. Their seeds are also purchased by some private companies. The project does not have support for packaging the seeds in small quantity, say 2kg or 10 kg bag for marketing. BADC and private companies' seeds are processed and packaged in small quantity in attractive bags. DAE seed faces competition with other's finished products in the market. They also have problem of processing the seeds using the processing facilities of BADC. Storage is another problem. The project provides polythene and gunny bags for preservation of 400 kg seeds per demonstration, which is sufficient for only 40% of the total quantity of seeds produced. The farmers are required to preserve the remaining 60% seeds on their own. The project provides jute bags instead of plastic drum to preserve seeds. Jute bag is not the appropriate material for preserving seeds for a longer period. The other major problem is the lack of capacity of small farmers to retain the entire quantity of seeds. They are forced to sell some of the seeds, when they need cash money to meet the family needs.

3.5 The seed industry in the private sector is getting more organized. Many small companies have taken the business seriously. This is more conspicuous in Bogra district. Even the small companies have established smaller size seed processing facilities with locally produced winnower and grader, and low cost Chinese bag-sealing machine and moisture meter. They have made attractive 2 kg and 50 kg seed packaging bags with proper labeling and SCA's certification tags. The main problem the companies are facing is the uneven seed market due to sale of BADC seeds at a highly subsidized price. The price of BADC rice seeds has been fixed at Tk. 22/kg at dealers level. The price at retailers' level is Tk. 28-30/kg. Costing of seed produced by BADC and private seed producers is about Tk. 35/kg. While BADC sell their seeds at Tk. 22/kg, private seed companies have to sell at Tk. 40-45/kg to wholesale dealers. The price at retailers' level is Tk. 50-60/kg. This is what is discouraging the private companies to produce quality seeds in larger quantities.

3.6 Many private seed companies like Mahim Seeds, Classic Agrovision, Tusher Seeds, Mahasthan Bijghar, and Master Seed Co. in Bogra district provide seeds mainly of rice. They produce Foundation Seeds and TLS of rice. Syngenta, a multinational company, has started rice breeding program mainly with hybrid rice in Bogra district. They have also created excellent training facilities. These companies get Breeders Seeds from BRRI, and Foundation Seeds from BADC. They are equipped to produce larger quantity of quality seeds. They have their own contract growers. They sell their seeds mainly through dealers.

3.7 The seed producers of Bogra, Rangpur, Thakurgaon and Dinajpur are facing the problem of getting the results of seed tests in time from Ishurdi Seed Testing Laboratories. Most of the time, they receive the results from Ishurdi Seed Testing Laboratories (STL) after one month or so; and they cannot enter early in the market with their seeds. Since TLS do not require seed tests, BADC enters the market early with TLS. Seed Testing Laboratories at Ishurdi is the only laboratories serving the entire Northern region which is best suited for seed production.

3.8 *Seed quality:* The problem of low quality seeds still exists. Interactions with farmers and field extension staff clearly indicate that not all the seeds available in the market are of good quality. Seed quality of most private companies has improved. The farmers are less interested to buy BADC seeds. It is evident from field investigations and random spot checking that not all the Truthfully Labeled Seeds (TLS) are truly TLS. This is true for TLS of BADC as well as of some private companies. Since BADC is selling TLS without certification, some private companies are also selling the SCA-rejected foundation seeds as TLS. It was found in Bogra during physical verification. Some of BADC's Foundation Seeds are also not 100% pure. Varietal admixtures alone were found to vary from 10-15%. Unfilled and poorly filled grains were also found in the

stock. It was observed that a trend of negative attitude among farmers, extension workers and SCA field staff was growing against TLS of BADC. Field investigations show that some of the hybrid rice varieties are highly susceptible to pests and diseases, and the eating quality of some is very poor. One must admit that quality seed production in Bogra district is getting well organized due to strict enforcement of rules by SCA. The Seed Companies have started to recognize the value of SCA, and they strictly comply with their requirements.

3.9 Poor quality seed is the result of introduction of TLS. TLS are exempted from quality certification by SCA. No one has any control over TLS. These seed lots are certified by the producers themselves. This has opened the window for selling any kind of seeds in the name of TLS. It is inconceivable how TLS are exempted from quality certification by SCA, when the Breeder's Seeds require certification. Quality of some hybrid rice is also in question.

3.10 Good seed policies and rules have been framed, but enforcement is lacking. Seed Certification Agency (SCA) was created in 1974 with manpower strength of 221 to ensure field standard and seed standard and certify the quality of 10,000 tons of rice seeds and 2,000 tons of wheat seeds of BADC. Since then, its sphere of activities has increased many folds. SCA will had to examine and certify 57,000 tons of rice seed, 23,000 tons of wheat seed, 1,430 tons of jute seed and 21,000 tons of potato seeds of BADC alone in 2009-10. In addition, it will have to cover seeds to be produced or imported by more than 5,000 private seed companies as well as seeds of DAE's Seed Project. The manpower strength almost remains the same 223. One District Officer, at present, is covering 3-4 districts and that also without transport facility. An additional strength of 112 positions have been approved and cleared by the Ministry of Finance; but it is stuck somewhere in the Ministry of Agriculture for unknown reasons.

3.11 The SCA is supposed to be an independent regulatory body. But in reality, it is tightly controlled by three bodies: (i) administrative part by the Administration Section of the Ministry; (ii) technical part by the Seed Wing of the Ministry; and (iii) human resources by DAE. SCA is manned by DAE officers, including the position of Director. Frequent transfer of DAE officers destabilizes the program of SCA frequently. SCA has no power to retain its trained and experienced professionals. Seed producing organizations with few exceptions are more powerful than SCA. Seed Wing of the Ministry is supposed to be a neutral body; but it is manned by officers of BADC which is the main client of the Seed Wing and SCA. It is an interesting case that the clients are controlling the regulatory bodies. SCA finds it hard to enforce the approved seed policy and laws.

Seed production and seed dealership license is given by the Seed Wing; SCA has no involvement in it. It is reported that the licenses are given without properly verifying field reports.

3.12 The Ministry of Agriculture (MOA) is making special efforts to increase production of quality seeds of important food crops. In doing so, it is probably unknowingly imposing higher targets beyond the capacity of BADC and Research Institutes. This is indirectly creating negative effect on seed quality. Field investigations show that BADC is buying seeds from farmers' field to meet the requirements of truthfully labeled seeds (TLS). BRRI also has to produce Breeder Seds beyond their capacity. BRRI's maximum capacity is to produce 40 tons of Breeder Seeds; but they have been asked to produce 100 tons. As a result, the seeds produced by BADC and BRRI are below the standard quality. This was revealed in field studies in 2004, and also in this study.

Problems and Issues

- Marketing of poor quality seeds: apply stringent quality control measures
- TLS without quality certification: Impose certification
- Manning MOA Seed Wing by BADC staff: Man by breeders
- Maintaining SCA as a lame horse: Strengthening SCA

4.0 Fertilizer

4.1 The types of fertilizer mostly used in Bangladesh are Urea, TSP. DAP, MOP, Gypsum and Zinc Sulfate. In a recent study by Karim (2007), growth of fertilizer use in Bangladesh in 2005-06 was shown to be negative (-2.9%) compared to positive growth in India (12.4%), Pakistan (3%), Sri Lanka (15.2%) and Nepal (3%). In 2005-06, the total quantity of fertilizers used was 3.7 million MT of which 2.5 million MT was urea, showing 3% decrease in fertilizer use over 2004-05 (Karim 2007). During this period, consumption of fertilizers in South Asia region registered a growth rate of 8.4%. The findings also show that the farmers use more of urea than TSP, DAP and MOP. The NPK consumption ratio in 2005-06 was 9.5:1.1:1, clearly showing imbalanced use of fertilizers which is not only affecting production but also affecting soil fertility. About 60% of Urea and 50% of TSP, MOP, DAP, Gypsum and Zinc Sulfate are used in Boro rice, indicating less use of these fertilizers in Aus and Aman rice, and other rabi crops, vegetables and fruits.

4.2 ***Fertilizer requirements and supply:*** The national requirement of fertilizers, local production and import targets are jointly determined by the Government and the private sectors. Karim shows in his studies that there has been under estimation of the requirements of all fertilizers. He shows a demand-supply gap of urea,

TSP, DAP and MOP (Table 1). The demand of different fertilizers estimated for 2009-10 crop year is urea 3.5 million MT, TSP 0.7 million MT, MOP 0.5 million MT, DAP 0.3 million MT, Gypsum 0.2 million MT, Zinc Sulfate 0.1 million MT. Allocation of different fertilizers approved for 2009-10 is urea 2.80 MT, TSP 0.60 MT, MOP 0.45 MT, DAP 0.25 MT, Gypsum 0.12 MT and Zinc Sulfate 0.05 MT.

4.3 Fertilizers are supplied by BCIC, BFA, BADC and private traders through dealers and open market sale. Most of the fertilizers are imported; only part of urea and DAP are locally produced. BCIC produced about 2.1 million MT of urea in 2002-03, the highest ever. The production has declined since then. Domestic production of urea, TSP and DAP in 2009-2010 will be 1.3 million MT, 0.13-0.15 million MT and 0.13 million MT respectively.

Table 1: Fertilizer Demand and Supply Position in Lac MT (2007-08)

Fertilizer Type	Govt. Estimated Demand	Field Estimated Demand	Gap
Urea	28.14	35.2	7.0
TSP	4.75	5.9	1.2
DAP	2.5	3.2	0.7
MOP	4.0	5.0	1.0

4.4 ***Fertilizer import:*** Fertilizers are imported by BCIC, BADC and private enterprises from different countries (India, China, Tunisia, Morocco and Belarus). BCIC imports urea only. The Government allocates certain quantity of TSP and MOP for import by BADC every year. The allocation for 2009-2010 is 100,000 metric tons of TSP and 75,000 metric tons of MOP with the provision of another 50,000 tons each of TSP and MOP, if required. Rest of the requirements of TSP, MOP and all of SSP, DAP and other fertilizers are imported by the private sector. Mixed market (SRDI 2008). The quality of imported fertilizers and the price vary widely. Some brands of fertilizers, imported from India and China, are reported to be of low quality; their prices also vary from Tk. 1,000-1,500/ per 50 kg bag. Some unscrupulous importers and dealers do not show percent of nutrient content and country of origin on the bag. License No. is also not mentioned.

4.5 ***Fertilizer distribution and use:*** Fertilizer distribution system has improved due to the policy of selling fertilizers in the open market. The farmers has not encountered fertilizer crisis this year other than its quality. Fertilizers have been available in the market at the prices fixed by the Government. But due to very high price of fertilizers other than urea, majority of the farmers either did not use or grossly underused TSP, DAP, MOP, SSP and other fertilizers. Field investigations and interviews with farmers reveal that fertilizer use was highly imbalanced in 2008-09.

4.6 ***Fertilizer quality:*** One of the most critical problems, at present, is the marketing of poor quality fertilizers. For example, TSP imported from Tunisia, Morocco and Belarus contains 46% of P_2O_5, whereas some of TSP imported from China and India contains 25-26% of P_2O_5. A group of dishonest traders is producing, importing and marketing very poor quality fertilizers. Field investigations reveal that certain brand of TSP fertilizer does not dissolve in water even after a month. Adulteration of fertilizer is the other part of the problem. It is done in different ways in different parts of the country, and pushed into the market. The details are given in a handbook, published by SRDI. The name of the handbook is "Methods of Identification of Adulterated Fertilizers in the Field". Farmers and field extension staff report that mixed fertilizer, produced in Bangladesh, is the worst example of ineffective fertilizer. Results of laboratory tests conducted by SRDI show that the quality of 90% of the mixed fertilizers and organic fertilizers are sub-standard. Some organic fertilizers were found to contain as high as 4000 PPM of cadmium against the allowable limit of 10 PPM only (BARC). Low quality fertilizers of different brands are also coming from India through the black route. These fertilizers are adulterated in the border area and sold in the market.

4.7 In 2008-09, the market was flooded with low quality and adulterated non-urea fertilizers. Despite adequate measures in place, such as laboratory tests, Upazila and District Seed and Fertilizer Monitoring Committees, checking quality of imported fertilizers at landing in the port, and Fertilizer Management Law 2007, it was not possible to stop marketing of low quality and adulterated fertilizers. Apparently, the existing measures are not working effectively.

Problems and Issues

- Import and marketing of low quality fertilizer: Stringent quality control needed
- Fertilizer smuggling and adulteration: Appropriate action needed
- Poor quality mixed and organic fertilizer: Legal action needed
- Lack of enforcement of Fertilizer Management Law: Enforcement needed

5.0 Irrigation

5.1 Large scale irrigation is under the Water Development Board. Area under large scale irrigation is less than 10% (Boro season). Irrigation of more than 90% of the Boro area is covered by small scale irrigation (STW, DTW and LLP). Shallow Tube Well is fully privatized; LLP is also mostly privatized; and DTW is managed by BADC, Borendra Multipurpose

Development Authority (BMDA) and the private sector. A picture of surface and ground water use by different modes in 2007-08 is given in Annex 1 (MOA 2008). About 90% of DTW, 14% of STW and 8% of LLP are run by electricity. The number of STW used for irrigation is much larger than DTW and LLP. Only 14% of irrigation equipment is run by electricity; the rest are run by diesel.

5.2 Unplanned sinking of STW and DTW has created a major problem with small scale irrigation. On the one hand, the use of STW has increased by about 3 times during the last more than a decade and on the other hand, irrigated area per STW has decreased by more than 22% (Alam, 2006). Continued lowering of water table due to unplanned withdrawal of ground water is the main cause of this reduction. DTW, particularly in Barind Tract is facing serious problem due to lowering of water table during the dry season (March-April). In a groundwater zone mapping study for the entire country (Alam, 2006), BADC identified the "critical STW zone", covering about 23,389 sq. km in 31 districts. This area must have further increased by now. The entire Barind Tract belongs to the critical zone. The Ministry of Defense is planning to undertake a digital mapping project, titled "Improvement of Digital Mapping System", covering the whole country. Once this mapping is done, BADC can update their ground water zone on the basis of these digital maps.

5.3 Low water use efficiency and poor on-farm water management not only increase the irrigation cost but also decrease irrigation coverage. Water use efficiency in Bangladesh is the lowest in the sub-continent; it was only 30% in 1990 as reported by IWMI. It should be mentioned here that none of the Govt. Institute/organization has measured the irrigation efficiency, though it is an essential indicator for economic use of irrigation water. Water use efficiency in Yemen, Bulgaria, Denmark, Sweden, Switzerland and Albania reached 70% (Alam, BADC). It is possible to increase the efficiency to 60% in Bangladesh, if on-farm water management is improved and appropriate minor irrigation policy is adopted. BADC has developed a mathematical model (Alam 2005) which convincingly shows that if the irrigation efficiency is increased from the existing 35% to 42.5%, Boro rice production will increase up to 21.5 million metric tons against the present production of 17.5 million metric tons. They have also shown that the present per ha yield of 3.5 tons of Boro rice could be increased to 4.5 tons/ha in the short run and to 6.0 tons/ha in the long run.

5.4 ***Irrigation water management:*** BADC is currently implementing six surface and ground water irrigation projects, in addition to 12 integrated agricultural development and surface water irrigation projects, where the use of DTW-based buried pipe irrigation technology has been included to improve water use efficiency. BADC is also working on 6 water storage and drainage programs in Haor/Beel areas; and another 27 special irrigation expansion programs in other parts of the country. In addition, BADC has 2 more survey, monitoring and data collection programs to determine the impact of climate change on availability and quality of irrigation water. BMDA is implementing a large surface water use project named "Rainwater Conservation and Irrigation". RDA, Bogra is also working on minor irrigation and buried pipe technology.

5.5 The Agricultural Engineering Program of DAE is working on improving conveyance and application efficiency of irrigation water by redesigning and adjusting irrigation channel. They are also working on STW-based buried pipe technology as well as sprinkler and dip irrigation. They are experimenting with a new technology "Shower Irrigation", and have taken the initiative of introducing multipurpose DTW program for multipurpose use of water from the same source. They have a field program to expand alternate wetting and drying (AWD) system of irrigation to increase water use efficiency and reduce irrigation cost. They have also undertaken on-farm water management program on consumptive use of ground and surface water to increase water use efficiency.

5.6 The Local Government Engineering Department (LGED) of the Ministry of Local Government, Rural Development and Cooperatives has a program on surface water control, drainage and irrigation. They have completed 280 water resources management sub-projects in Phase 1, covering 37 districts under ADB funding. Another 300 sub-projects, covering 61 districts, under ADB funding are being implemented in Phase 2. Phase 3, covering 46 districts to implement 400 sub-projects (250 new and 150 old for upgrading) is being negotiated with ADB. LGED is also implementing a Small Scale Water Resources Development Project in greater Mymensingh, Sylhet and Faridpur through about 200 sub-projects, covering 15 districts under JBIC funding. A follow up Small Scale Participatory Water Resources Project is in the process of loan approval with ADB, IFAD, GON and GOB. This project will cover the entire country.

5.7 Irrigation efficiency was 30% in 1990, which has increased to 35% shown in a Ph.D. thesis study conducted by Eftekharul Alam (2009). According to him, irrigation efficiency can be increased up to 45-47% in the short term; and if it is done, 6-8% increment will come from software activities like training and demonstration of Government staff and farmers on appropriate on-farm water management technology (Alternate Wetting and Drying and proper use of fertilizer-irrigation

technology), and the remaining part will come from hardware activities like lining and buried pipe technology.

5.8 One of the factors that can create high impact on per unit yield is on-farm water management. Technologies such as buried pipe irrigation, alternate drying and wetting, drip irrigation, shower irrigation, and improved water conveyance system are available. Special drive is needed to organize and disseminate on-farm water management techniques. DAE Engineering Program has altogether as many as 140 projects; and BADC has 18 projects of which 8 are being implemented, and 10 are waiting for final approval. Another list of 36 projects, covering almost the entire haor and water logged areas of the country has been proposed. These initiatives are intended to increase irrigation coverage, water use efficiency and on-farm water management.

Problems and Issues

- Expansion of "Critical Ground Water Zone": Assessment needed
- Unplanned withdrawal of ground water: Revisit STW sinking policy & include appropriate formulae
- Low water use efficiency: increase water use efficiency
- Poor on-farm water management: Improve water management

6.0 Pesticide

6.1 A wide range of pesticides are available in the market. The list of registered pesticides and the list of banned pesticides have been published by the Plant Protection Wing of DAE in 2008. The list is being updated. Every new entry of pesticide is adequately tested in both the laboratories and in the field; and the results are evaluated by a National Committee before permission is given for registration. Yet, according to the farmers and field extension staff, many of these pesticides were not only found highly ineffective but also causing total destruction of the crop. Many farmers lost the entire crop in 2008 due to use of inappropriate or ineffective pesticide. The special drive taken recently by the Director, Plant Protection Wing has revealed that some companies are selling unregistered pesticides under the cover of registered pesticide. Even growth hormones singly or in cocktail form, mixing with unregistered pesticides, are being sold in the market with use of floating agents. This is mainly done through small retail shops in the villages. These shops are also selling pesticides long after the expiry date.

Problems and Issues

- Import and marketing of unregistered pesticides: Legal action needed
- Lack of quality control: Quality control to be imposed

- Lack of monitoring: Strengthen monitoring & implement existing rules

7.0 Conclusion

7.1 The problems of input supply and management are extremely critical for increasing food production, particularly when production increase has to come from vertical yield increase per unit area. Arable land is decreasing, and food requirement is increasing due to rising population. By 2021, the size of population will be about 172 million. Food production has to be increased from decreasing land resources to feed this population. Not many options are open to achieve this target. All efforts will have to be directed to increase yield per unit area; and to do that it is imperative to give special attention to smooth supply of quality inputs and their proper management.

References

Agro-Economic Research Branch, Ministry of Agriculture 2007. Handbook of Agricultural Statistics.

Alam, E. 2006. Gound Water Zoning Map and Its Application, Presented in a National Seminar on Ground Water Zoning Map and Its Application.

Alam, E. 2006. Impact of Unplanned Withdrawal of Groundwater on Shallow Tube Well Irrigation in Bangladesh, BUET.

Alam, E. 2005. Needs, Prospects and Problems of Minor Irrigation in Bangladesh and Scope of BADC: A paper presented in a Seminar organized in Sech Bhaban, Dhaka.

Ali, M.S. 2009. The Role of Quality Rice Seed in Food Security of Bangladesh. The Guardian.

Asaduzzaman, M. Shahabuddin, Q. Deb, U.K. and Jones, S. 2009. Input Prices, Subsidies and Farmers' Incentives. BIDS Policy Brief, No. 0904.

Bangladesh Agricultural Research Council, Ministry of Agriculture. Fertilizer Recommendation Guide-2005.

Bangladesh Agricultural Research Council, Ministry of Agriculture, 1988. Action Plan for Production of 20 million tons of Food Grain by 1991-92.

BADC 2008. Minor Irrigation Survey Report 2007-08.Survey and Monitoring Project, Bangladesh Agricultural Development Corporation.

BADC 2009. Annual Report

BBS 2008. Bangladesh Bureau of Statistics, Ministry of Planning.

DAE 2009. Personal communication with the Director of Plant Protection and Project Director of Seed Project and Head of Fertilizer Management.

IRRI, 2007. Food Security for Sustainable Household Livelihoods (FoSHoL) Program: A Synthesis Report of First Cycle Baseline Study.

Karim 2009. Background Paper on Food and Agriculture: Crop, Forestry, Fisheries and Livestock. Submitted to Planning Commission.

Soil Resources Development Institute, Ministry of Agriculture, 2008. Upazila Land and Soil Resources Use Nirdeshika.

Annex 1

Surface and Ground Water Irrigation by Different Mode s (2007-08)

Mode of Irrigation	Number of Equipment	Area Irrigated (ha)	% of Total Irrigated Area (ha)	Area Irrigated per Equipment (ha)
Surface Water Irrigation				
Low lift pump	138630	903867	17.9	6.52
Gravity flow		138803	2.75	
Traditional method		19044	0.38	
Sub-Total	138630	1061714	21.02	
Ground water Irrigation				
DTW	31302	785680	15.56	25.10
STW	1304973	3197184	63.31	2.45
Manual and Artesian method		5207	0.10	
Sub-Total	1336275	3988071	78.98	
Grand Total	1474905	5049785	100.00	

Supply and Availability of Fertilizers as well as Soil Fertility Status and Its Management in Bangladesh

M. S. Islam[1]

Abstract

Fertilizer is one of the key inputs for increasing crop yields and its contribution to crop production is about 50-60%. The supply and availability of this key input at the doorstep of the farmers to sustain crop productivity in recent times has been made critical issue. Hue and cry for fertilizers in the beginning of every crop season is heard every where in the country. The unrest of the farmers to get fertilizers for feeding their hungry soils most often turn to violence. The government never admits about the shortage or crisis of fertilizer supply and availability in the country, but sometimes accepts that the shortfall is due to faulty marketing system. All these indicate the serious mismatches of supply and demand situation, and the faulty marketing system. The paper is written with a view to analyzing the existing fertilizer needs and supply scenario in the country with few suggestions on how to bring discipline in the marketing and supply channels so that the farmers can buy this agro input as and when they need for fertilizing their crops and thus help government attain self sufficiency in food crops. The use of chemical fertilizers in subsistence and food deficit East Pakistan (now Bangladesh) agriculture began in 1951 with import of 2698 tons of ammonium sulphate. The consumption increased steadily with time after introduction of modern varieties to feed teeming millions and reached value of about 4.00 million tons in 2006. Fertilizer production, import, distribution as well as marketing were with the government until 1991when privatization took place. But total production and import of urea as well as production of small quantities of TSP, SSP and DAP are controlled by the government. These fertilizers are distributed through BCIC appointed dealers. Import and marketing of the rest of TSP, DAP and other fertilizers (MOP, SOP, gypsum, magnesium sulphate and micronutrients) are controlled by private sector. Small quantities of NPKS fertilizers are being produced by various fertilizer companies in an effort to make balanced fertilization. Urea is heavily subsidized, while on imported TSP, DAP and MOP subsidy has been increased from 15% to 55-60% on 14 January 2009 and then again to 78-80% on 02 November 2009 through a lengthy bureaucratic system. Fertilizer demand is usually calculated by the Department of Agricultural Extension on the basis of nutrients needs and crop production projections. There is huge gap between productions (1.7 million tons) and demands (>4.0 million tons). Timely supply of locally produced and imported fertilizers at the farm gates are handicapped by various constraints that result in crisis. Prices of urea and other imported fertilizers should be fixed at per with those in the neighboring countries to check their smuggling out of the country. Fertilizers should be marketed like other essential commodities such as rice grain, common salt, edible oil, kerosene, etc in the open market. The farmers should be provided subsidies not only for buying fertilizers, but also for other agro input, such as seeds, pesticides, etc. Two more urea fertilizer factories (each 0.5 million capacity) - one in the northern and another in southern-western districts should be established to minimize the shortfall of urea. Full functioning of the DAP plants should be started as soon as possible to reduce its import. The fertility and productivity of the country's most important natural resource soil must be maintained at any cost to face the challenges of growing more food in the country where food security is crucial for poverty stricken people, about 2 million people are added to the total population every year and where the natural resources including agricultural land are shrinking. Therefore, the use of organic fertilizers must be promoted to sustain soil health and thereby to reduce dependency on chemical fertilizers. All organic resources should be mobilized and recycled through composting or as raw materials for production of biogas to meet rural fuel crisis and good quality bioslurry as organic manures for integration with chemical fertilizers.

[1] Soil Scientist and Former Director General, BARI

Introduction

Fertilizer is one of the key inputs for increasing crop yields and its contribution to crop production is about 50-60%. Fertilizers supply essential plant nutrients necessary for the proper growth and development of crops/plants. The nutrients constitute the essential parts of cells such as chlorophyll, nucleic acids, DNA and RNA.

The production of cereal crops in the country has increased significantly from 10 million tons in 1970-71 to 34.2 million tons in 2008-09. This is due to the use of modern farm inputs such as HYV seeds, fertilizers, pesticides and irrigation. To understand the role of fertilizer for increasing crop production the remark of Nobel Prize winning wheat scientist Dr Norman E Borlaug may be understood as follows:

"If the high yielding wheat and rice varieties were the catalyst that ignited the Green Revolution, then chemical fertilizer was the fuel that poured its forward thrust".

This is also true for Bangladesh agriculture as the country has virtually no possibility of increasing her cultivable land area. Therefore, food production in the country can be increased through increasing irrigation facilities together with HYV and balanced use of fertilizers.

Although fertilizer is a critical input, its distribution and availability at the farmers' door step to sustain c rop productivity has many constraints and bottlenecks. The whole system of fertilizer marketing has been made unnecessarily lengthy and complicated. Hue and cry for fertilizers in the beginning of every crop season is heard everywhere in the country. The unrest of the farmers to get fertilizers for fertilizing their hungry soils most often turn to violence. The government never admits the shortage or crisis of fertilizer supply in the country, but sometimes accepts that the shortfall is due to faulty marketing system.

In spite of the difficulty and lengthy system of getting the appropriate amount of fertilizers, the hard-working farmers of the country do not hesitate to adopt modern management practices which have increased the cropping intensity to about 185%.This intensification has led to an increasing demand for fertilizers. Therefore, it is the moral duty of the government to ensure adequate supply of fertilizers to meet the increasing demand. It is being observed with concerns that that imbalanced use of fertilizers is causing land degradation. Excessive mining of plant nutrients has resulted in declining of soil fertility in one hand and reduction of yield on the other. Therefore, the government should take pragmatic measures so that the farmers use balanced fertilizers for optimum crop production as well as for maintenance of soil health in high fertility state. Under the above circumstances, the present paper is written to overview the existing fertilizer scenario in the country in respect of use, distribution, subsidy, marketing, production, nutrient situations in soils as well as agronomic use efficiency.

Fertilizer Use in Bangladesh

The use of chemical fertilizers in Bangladesh agriculture started with import of 2698 tons of ammonium sulphate in 1951-52. The use of urea and TSP began in 1957-58. Muriate of potash (MOP) was added to the fertilizer schedule from 1960. The fertilizer consumption rose from 2698 tons in 1951-52 to 58753 tons in 1961-62. The fertilizer use increased to 10.61 lakh tons in 1965-66 and the increasing trend steadily continued through 1970-71 raising the volume of use to 30.43 lakh tons. Fertilizer use sharply increased with the introduction of high yielding rice varieties. After the liberation war, significant consumption of fertilizers was noted during 1975-76. Since then increasing trend of fertilizer was being observed which reached peak value of 40.09 lakh tons (more than 4 million tons) during 2005-06 (Table 1). Along with urea, phosphate and potash, the use of gypsum, zinc sulphate and other micronutrients were also increased. During 2002-03 to 2004-05 considerable amounts of NPKS mixed fertilizers were used in an attempt to make balanced fertilization.

Table 1. Consumption of different fertilizers in Bangladesh during the last 44 years (mt).

Year	Urea	TSP	SSP	DAP	MOP	Gypsum	Zinc sulphate	Ammonium sulphate	Others	Total
1965-66	832	200	---	---	27	---	---	---	20	1059
1970-71	2123	749	---	---	171	---	---	---	---	3043
1975-76	3119	1090	---	---	221	---	---	---	19	4449
1984-85	831801	345670	---	403	69271	1379	1217	---	10480	1260221
1989-90	1369237	479767	718	---	118633	67808	5180	1785	18	2043176
1990-91	1323397	514761	12120	---	149761	101782	2743	2763	211	2107538
1991-92	1533481	456672	36201	---	137135	115334	3805	4797	---	2287425
1992-93	1547407	107002	119828	2010	126083	108140	722	4992	---	2316184
1993-94	1578955	234185	170608	28675	103875	86051	5200	10036	97	2217682
1994-95	1748459	12294	533485	1837	154240	77161	---	2491	---	2640620
1995-96	2045535	111095	596881	---	155881	103577	1029	8692	---	3022690
1996-97	2119883	72629	525285	---	219302	86611	1161	11692	---	3036563
1997-98	1872725	62382	473295	6778	193496	113430	661	9716	---	2732483
1998-99	1902024	170247	362370	38633	210748	128215	269	12418	---	2824924
1999-00	2142100	360000	332000	169000	270000	130000	15400	13500	---	3432000
2000-01	2111000	405000	121000	94000	133000	140000	15500	13500	13000	3046590
2001-02	2248000	425000	127000	127000	243000	96000	3000	13500	10000	3292500
2002-03	2247000	375000	133000	121000	271000	100000	5000	13500	13000	3278500
2003-04	2350000	450000	120000	200000	325000	120000	6000	13500	26000	3610500
2004-05	2487000	410800	163900	161000	352700	68700	10000	20000	99000	3773500
2005-06	2600000	450000	125000	175000	300000	150000	25000	20000	160000	4005000
2006-07	2575000	340000	122000	115000	230000	72000	26000	6000	125000	3551000
2007-08	2685000	380000	100000	240000	380000	160000	45000	-	100000	4090000
2008-09	2400000	200000	25000	50000	150000	10000	30000	-	50000	3005000

Source: MoA (2009)

Fertilizer Distribution System

Fertilizer marketing, promotion and distribution in the country started in late fifties. The Department of Agriculture was solely responsible for import, storage, distribution and retail sale among the farmers. For various reasons, this distribution system was not satisfactory. This was reflected in the Report of Food and Agriculture Commission published in 1960. This report also suggested establishing an autonomous organization which would be responsible for proper distribution and marketing of fertilizers along with other agricultural inputs on commercial basis. On the basis of this report, Bangladesh Agricultural Development Corporation (BADC) was created in 1961, and the distribution and marketing of fertilizers along with other inputs were officially handed over to this organization. BADC took over the fertilizer distribution program in 1963 and appointed dealers in the unions for making fertilizers easily available to the doorsteps of the farmers. The dealers lifted fertilizers from the BADC thana godowns and sold them to the farmers at prices fixed by the government. They got commission on the basis of their sale volume. BADC was responsible for maintaining sufficient stock at the godowns.

This system of fertilizer distribution did not work well because of BADC's gross irregularities in appointing dealers and also of unnecessary bottlenecks for getting clearance from Thana Committee and polices. Under the system, the dealers could not sell the fertilizers beyond their areas unnecessarily fixed up by the Thana Committee.

In 1975 the dealership system was reformed. The dealers were allowed to sell the fertilizers in village markets. During the fertilizer crisis in 1974 the number of the dealers was reduced to 3 per thana; later on, the number was increased to 15. The dealers were given special discount on sale volume. Previously, the dealers were allowed to lift fertilizers from their own thana godowns, but under the changed system they could lift fertilizers from any thana godown convenient to them.

In order to bring more effectiveness in the fertilizer distribution system, a New Marketing System (NMS) known as Fertilizer Distribution Improvement (FDI-I) project was launched under the assistance of USAID from December 1978 up to July 1980. This system brought about quality changes in fertilizer distribution. The dealers were given more responsibility and financial facilities to them were increased. Under the system, 101 Primary Distribution Points were opened. This system reduced the transportation and storage costs. The whole sellers and retailers were given responsibility to distribute the fertilizers to the farmers. All restrictions were withdrawn over the dealers so that they could sell the fertilizers on competitive basis in the free market. The government monitored the prices of the fertilizers along these reforms.

The last reform under FDI-I was to withdraw price control over sale of fertilizers at the farmers' level. This system was introduced in the Chittagong division first and then gradually all over the country during 1982-83. This reform brought about substantial improvement in fertilizer distribution system as there was no increase in the fertilizer prices.

This system continued up to 1987 when FDI-II was initiated. Under FDI-II, the private dealers could lift the fertilizers from 4 Transport Discount Points at reduced rate. This was the first step towards privatization of fertilizer distribution system from BADC. With the introduction of this system, the price of the fertilizers was reduced under command areas of the dealers. This system passed through success and failure. In 1989 there was severe crisis of fertilizer availability at the farmers' level in spite of sufficient stocks in the godown. Under such situations, the government made some

reforms. The dealers were allowed to lift urea first time from Ghorasal Urea Fertilizer Factory and then gradually from other factories at prices fixed up for BADC to lift .The private dealers were also allowed to import urea fertilizers from abroad.

All the above measures helped the farmers get fertilizers at reduced rates and there was substantial improvement in the distribution system. From 1990-91 the government allowed the private companies/dealers to import all kinds of fertilizers from abroad. For some time, both BADC and private companies/dealers imported fertilizers from abroad. Later on, because of high competition with the private companies and high prices of BADC imported fertilizers, the latter was instructed by the government to shut down all fertilizer business activities (Table 2). This is how the privatization of fertilizer distribution took place in the country.

Table 2. Prices of fertilizers imported by BADC and private companies during 1991-92.

Name of fertilizer		Import (mt)	C & F price (US$)/mt	Exporting countries	Date of arrival in Bangladesh
TSP	BADC	14450	220.15	Morocco	22.07.91
		20994	194.00	USA	13.11.91
		20877	194.00	USA	04.12.91
		19350	203.00	Morocco	31.12.91
		14000	201.75	USA	17.01.92
		25004	209.65	USA	07.02.92
	Private companies	24200	178.00	USA	06.11.91
		16765	189.00	Indonesia	11.12.91
		7667	186.00	Indonesia	30.12.91
		16809	180.00	USA	05.01.92
		15937	190.00	USA	05.02.92
MoP	BADC	18764	154.16	Canada	13.11.91
	Private companies	19925	142.88	Canada	18.12.91

With time passing on, privatization of fertilization distribution system proved successful and was appreciated internationally. As a result the sale volume of fertilizers rose to 22.18 lakh tons during 1993-94. Unfortunately, severe crisis of urea fertilizer occurred during boro season of 1995. The main causes for such shortfall were:

i) *There was no information on the supply situation of urea fertilizer when the FDI-II project activities ended at the end of 1994*

ii) *BCIC exported urea fertilizer flatly without considering the supply and demand situation in the country.*

Because of short supply of urea fertilizer in the market, unrest grew among the farmers who demonstrated in the street and were desperate to get the fertilizer for which their boro crops were suffering badly. Finding on other alternative, the government engaged law enforcing agencies which brought the situation under control.

After the incidence, the government discussed the supply and availability issues of fertilizers with the Bangladesh Fertilizer Association and, decided to appoint dealers in 1995. Thus, with the appointment of new dealers the distribution of urea entered into a new era which is still being continued. These dealers can also lift TSP and SSP from the BCIC factories and buffer stocks for distribution among the farmers in their command areas.

Present Fertilizer Distribution System

All fertilizer requirements of the country such as TSP, DAP, MOP and urea (about 40-50%), etc are met through import by the private companies. Out of total requirement of urea (28.00 lakh tons during 2007-08), only 14.50 lakh tons and small amount of TSP (0.50 lakh ton) as well as SSP (1.00 lakh ton) were produced within the country from 6 urea fertilizer factories and TSP Complex. The low production of urea was due to sudden closure of Ghorasal urea fertilizer factory. The rest amount of urea (13.50 lakh tons) was imported to meet the demand.

Urea production and import is always controlled by the government, and is distributed to the farmers in the country through 4850 BCIC appointed dealers at heavily subsidized rates. Total production capacity from 6 urea fertilizer factories is 17 lakh tons, although installed capacity is about 23 lakh tons.

The private importers import TSP, DAP and MOP from USA, Tunisia, Australia, Jordan, Morocco CIS and China according to the annual needs of the country. After import, the fertilizers are marketed through the different dealers appointed across the country.

Fertilizer Subsidy

The prices of TSP, DAP and MOP increased abruptly in the international market at the end of 2003 and

beginning of 2004. Due to price hike, the balanced use of fertilizer was being seriously affected. The Bangladesh Fertilizer Association (BFA) proposed to the government about the introduction of subsidy on these fertilizers so that the farmers could use balanced fertilizers for their crops. The government considered BFA's proposal favorably and decided to provide 25% subsidy on these fertilizers. During 2004-05 and 2005-06 the government provided Tk 261.14 and 371.28 crores as subsidy for the phosphate and potash fertilizers. This subsidy helped the farmers get fertilizers at reasonable prices and thus crop production increased significantly in the country. To give a clear understanding on the benefit of subsidy, comparative prices are quoted in Table 3.

Table 3. Comparative prices (Tk) of 50 kg TSP, DAP and MoP bag during 2004-2010.

Fertilizer	2004-05		2005-06		2006-07	
	Without subsidy	With subsidy	Without subsidy	With subsidy	Without subsidy	With subsidy
TSP	673-803	504-602	800-936	600-702	870	650
DAP	958-991	719-743	1112-1238	872-928	1340	1000
MoP	678-689	506-517	796-847	597-635	800	600

Fertilizer	2007-08		2008-09		*2008-09	
	Without subsidy	With subsidy	Without subsidy	With subsidy	Without subsidy	With subsidy
TSP	1560	1325	4700	3500	4700	1900
DAP	2106	1790	5000	4250	5000	2150
MoP	1618	1375	3765	3200	3765	1650

Fertilizer	2009-10		**2009-10	
	Without subsidy	With subsidy	Without subsidy	With subsidy
TSP	4700	1900	4700	1000
DAP	5000	2150	5000	1400
MoP	3765	1650	3765	1150

*Governemt announced approximately 55-60% more subsidy on 14 January 2009
**Governemt announced approximately 78-80% more subsidy on 02 November 2009

Method of Subsidy Payment

The method of subsidy payment is complicated and bureaucratic. It passes through different committees such as information cell, storage enquiry subcommittee, price fixation subcommittee, price fixation & monitoring committee and finally steering committee under which the prices the of phosphate and potash are fixed.

However, the government has made some changes recently. Demand order issued in favour of the dealers against the receipt of the importers may be regarded as a document towards getting the 25% deducted amount. This may save time for the importers to get subsidy bill soon. It may be mentioned that the previous caretaker government reduced the subsidy of imported TSP, DAP and MOP from 25 to 15% in spite of their high prices from July 2007. However, in view of high import prices of TSP, DAP and MOP and inability of the farmers to purchase such costly fertilizers, the present government announced approximately 55-60% more subsidy on 14 January 2009. Still the prices were beyond the purchasing capacity of the farmers. The government again revised the subsidy and increased it to 78-80% on 02 November 2009.

The government has been providing heavy subsidy on urea fertilizer which provides the key nutrient nitrogen critically deficient in the country's soils. Before 10 June 2008 the government provided Tk 2200.00 subsidy per ton for domestically produced urea fertilizer while the subsidy amount for the imported urea was Tk 25000.00 per ton. The dealers could lift urea from BCIC urea mill gates at Tk 4800.00 per ton and imported urea from buffer godown at Tk 5300.00 per ton.

The government has reduced the subsidy on urea that became effective from 11 June 2008. The present price of urea at the mill gate is Tk 10000.00 and at the buffer gate Tk 10700.00. The dealer can sell urea among the farmers at Tk 11-12 per kg.

Present Supply and Availability Situations

The Ministry of Agriculture, in consultation with the Department of Agricultural Extension and its recommendation on requirements made through field survey, fixes up monthly as well as annual requirement of fertilizers. Besides demand requirement, the Ministry also makes a total exercise on production, import and price fixation. Table 4 shows the total scenario during 2008-09.

It is quite evident that there was shortfall of 13.50 lakh tons of urea which the government met through import and local purchase from Karnafuli Fertilizer Company (KAFCO). TSP and DAP amounting to 4.50 and 1.00 lakh tons were imported by the private companies. BADC imported only 0.50 tons of TSP. Private Companies imported 3.50 lakh tons and BADC 0.50 lakh tons of MOP to meet potash

requirement. Most of the secondary and micronutrient fertilizers are produced in the country by the private companies.

Table 4. Demand, production, import and prices scenario of fertilizers during 2008-09.

Name of fertilizer	Demand (lakh mt)	Production (lakh mt)	Import (lakh mt) (by 35 importers & BADC)	Local price (Tk/mt)		C & F price (US $/mt)
				Factory	Buffer	
Urea	28.50	13.00 from 6 Urea Factories	13.50 (4.5 from KAFCO)	10,000.00	10,700.00	115 (Production) 500 (Import) 450 ($ last yr)
TSP	5.00	0.50	0.50 (BADC) 4.00 (Pvt. Sec)	65,000.00	74550	1065 (Import) 600 (last yr)
MOP	4.00		0.50 (BADC) 3.50 (Pvt. Sec)		73500	1050 560 (last yr)
DAP	2.00	1.00 from 2 Factories	1.00 (Pvt. Sec)	99,500.00	94500	1350 1000(last yr.)

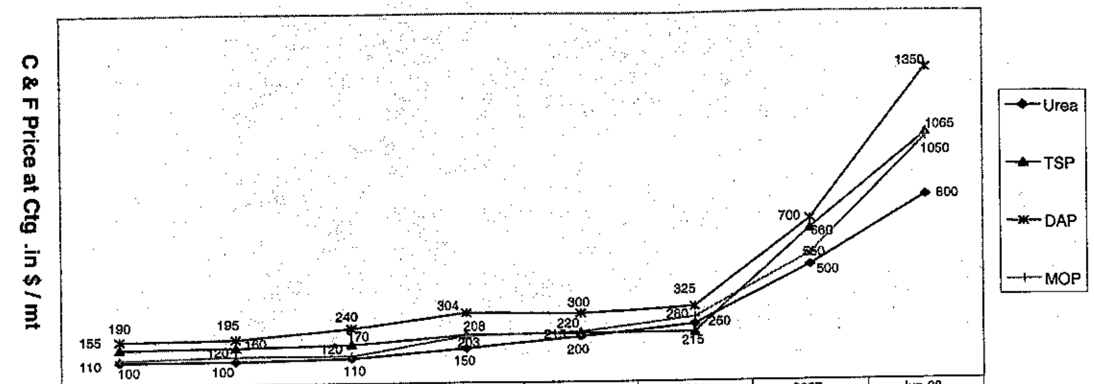
Table 4 (contd.)

SSP (Powder)	1.00	1.00	Embargo	10,500		
NPKS	1.50	1.50 By 33 Manufacture unit	-	26,979 (8:20:14:5) 28,386 (12:15:20:6)	44,000 (8:20:14:5)	-
Gypsum	1.50	0.60 from TSP Complex	0.90 (Pvt Sec)	-	-	-
$ZnSO_4$	0.50	0.10	0.40	-	-	-
AS	0.25	0.12	0.13	-	-	-
$MgSO_4$	0.20		0.20	-	-	-

Price hike of fertilizers: Fig. 1 and Table 4 show that the prices of the fertilizers went up sharply in the international markets during the 2007-09 years because of high energy costs and shrinkage of fertilizer production materials. Comparative prices of fertilizers in 2007-2008 and 2008-2009 and January 2010 are shown in Table 5. However, the prices of fertilizers in the international market have started to decrease since November 2008.

Domestic Production

In Bangladesh urea, TSP and SSP are produced in the local industries, which can partly meet the total demand of the country. About 60000 phosphogypsum is produced as a byproduct from TSP factory. At present there are six urea and one TSP



	2001	2002	2003	2004	2005	2006	2007	Jun-08
Urea	100	100	110	150	200	250	500	800
TSP	155	160	170	208	215	215	660	1065
DAP	190	195	240	304	300	325	700	1350
MOP	110	120	120	203	220	280	550	1050

Years (2001-2007) & June-2008

Fig 1: Cost of urea, TSP, DAP and MOP in the international markets during 2001-08 and June 08.

Table 5. Comparative prices of fertilizers during 2007-08 and 2008-09 and January 2010.

Fertilizer	**Market price of fertilizers (Tk/ton)**		
	2007- 2008	**2008-2009**	**January 2010**
Urea	6000	12,,000	1,2000
TSP	30,000	65,000	2,200
DAP	36,000	99,000	30,,000
MOP	28,000	43,000	25000
AS-Imported	20,000	22,000	12,000
AS- BCIC	-	35,000	15000
$MgSO_4$	30,000	40,000	7,000
$ZnSO_4$ (Hepta)	35,000	70,000	35,000
$ZnSO_4$ (Mono)	55000	95,000	45,000
Boric acid	60,000	1,00000	80,000
Chelated Zn	-	4,50,000	4,50,000
Sulphur-90	40,000	70,000	70,000

factories in the country. Natural gas provides the feedstock for urea production. The BCIC is responsible for operation of all fertilizer factories in the country. All these factories can produce 1700000 tons of urea, 12000 tons of ammonium sulphate, 50000 tons of TSP, 100000 tons of DAP and 100000 tons of SSP. Additional requirements of urea, TSP, DAP and gypsum are met up through import. All MOP are imported (Table 6).

their smuggling out of the country. The farmers should be provided subsidies not only for fertilizers, but also for other agro input such as seeds, pesticides, etc. Two more urea fertilizer factories (each 0.5 million ton capacity) - one in the northern and another in southern-western districts should be established to minimize the shortfall of urea. Full functioning of the DAP plants should be started as soon as possible to reduce its import.

Table 6. Domestic Fertilizer Production during last 15 years (1994-95 to 2008-09).

Year	Production (tons)			
	Urea	TSP	SSP	DAP
1994-95	1976000	76000	81600	
1995-96	2134000	27500	79500	
1996-97	1638000	31700	100150	
1997-98	1883000	49700	100500	
1998-99	1607000	58600	122000	
1999-00	1704000	65000	127000	
2000-01	1883000	68000	120000	
2001-02	1546000	68000	120000	
2002-03	2057000	65600	136400	
2003-04	2164000	65000	135500	
2004-05	2200000	65000	134000	
2005-06	1700000	60000	100000	
2006-07	1700000	60000	100000	100000
2007-08	1400000	50000	100000	100000
2008-09	1300000	50000	100000	100000

Source: BCIC (2009)

Timely supply of locally produced and imported fertilizers at the farm gates are handicapped by various constraints that result in crisis. Prices of urea and other imported fertilizers should be fixed at per with those in the neighboring countries to check

There are more than 50 small zinc sulphate manufacturing factories in the country. These are mostly concentrated around Jessore. These factories produce 10-12 thousand tons granular monohydrate and crystalline

heptahydrate zinc sulphate. Some companies produce small amounts of boric acids also.

Fertilizer Types and Grades

The farmers of Bangladesh use mainly single or straight fertilizers as sources of their nutrients. Urea, TSP, DAP, SSP and MOP are the widely used straight fertilizers. Among them, urea shares about 66%, TSP 11%, SSP 4.3%, DAP 4.3% and MOP 9% of the total fertilizer use. Gypsum, ammonium sulphate, zinc sulphate, boric acid, magnesium sulphate and potassium sulphate account for the rest.

The government of Bangladesh has recommended 6 crop specific grades of mixed or blended fertilizers for balanced application of nutrient elements in the crop fields. These grades are:

1. NPKS (8-20-14-5) for HYV Rice
2. NPKS (10-24-17-6) for HYV Rice
3. NPKS (10-15-10-4) for Sugarcane
4. NPKS (14-22-15-6) for Sugarcane
5. NPKS (12-16-22-6.5) for Wheat and other Rabi crops
6. NPKS (12-15-20-6) for Wheat and other Rabi crops

Among the six grades, different companies produce only rice grades. Akhter Agro and Fertilizer Industries Ltd, Sabir Fertilizer and Chemical Complex, South Bengal Fertilizer Mills Ltd, Jamuna Agro Chemicals, Aftab Fertilizers, Northern Agro Service Ltd, NAFFCO, etc are producing and marketing about 1.5 lakh tons of mixed fertilizers for the farmers.

Present Soil Fertility Status

Although Bangladesh is a small country, it has wide variety and complexity of soils at short distances due to a diverse nature of physiography, parent materials, lands, and hydrology and drainage conditions. Due to intensive cropping, continuous changes are taking place in the soil fertility status due to organic matter depletion, nutrient deficiencies, drainage impedance/water logging followed by degradation of soil physical and chemical properties as well as soil salinity/acidity. Most of the soils are depleted and are in urgent need of replenishment with organic manure and chemical fertilizers if projected crop production target is to be obtained.

Nitrogen

Nitrogen is generally considered as the key nutrient in Bangladesh agriculture. Most of the agricultural soils are: critically deficient in this nutrient. The main reasons for such deficiency are:

- intense decomposition of organic matter
- rapid removal of mineralized products under high leaching conditions and
- removal by crops.

Total nitrogen content of Bangladesh soils range from 0.032% in the

Shallow Red-Brown Terrace Soils to 0.20% in Peat Soils. The approximate values of total nitrogen used to interpret soil test values are 0.090-0.181 % (low), 0.181-0.270% (medium) and 0.271-0.360% (optimum) for upland crops in loamy to clayey soils. In light textured soils, somewhat lower values are used to interpret the soil test results for upland crops. For wetland rice, soil test values for nitrogen interpreted as low, medium and optimum are 0.090-0.180, 0.181-0.271 and 0.271-0.360% respectively. The soil-testing laboratories of the NARS institutes use these critical levels for total nitrogen in soil. The critical nitrogen content in plant varies with kinds of crops, cultivars and growth stages.

Nitrogen being the most important nutrient element in soils, plays the most vital role in crop production in Bangladesh. Except few leguminous crops, all other crops respond dramatically to applied nitrogen irrespective of soil types, growing seasons and cultivars used. Practically high yielding varieties of different crops such as wheat, maize, potato, sweet potato, cabbage, brinjal, tomato, cauliflower and banana are highly responsive and need ample supply of fertilizer nitrogen to express their yield potentials; while cotton, tobacco, mustard and sugarcane are substantially responsive. Pulses and other legumes are less responsive to applied nitrogen in Bangladesh soils. For some leguminous crops, a starter nitrogen dose is considered essential for higher nodulation and production.

Responses of modern rice to applied nitrogen have been studied extensively throughout the country by a series of fertility trials. The average yield increase due to fertilizer N varies from 30 to 75%. In some cases, without applied N modern rice showed almost complete failure, while application of 100 kg N/ha along with other nutrients resulted in a very successful crop yielding 6-7 t/ha.

Phosphorus

Phosphorus is the second most important nutrient element limiting successful crop production. It becomes unavailable or fixed in the soils through a variety of ways. In acidic terrace and brown hill soils, phosphorus is largely fixed by iron and aluminum oxides at low pH, while in calcareous soils fixation occurs by calcium-magnesium carbonates. The net result of fixation is a decrease in the immediate availability of native and applied phosphorus.

In medium and heavy textured soils, the available P contents up to 7.50 µg g^{-1} soil is interpreted as low, 15.1-22.5 µg g^{-1} soil as medium and 22.51-30.0 µg g^{-1} soil as optimum for upland crops. In light textured soils, somewhat lower values are considered to interpret soil P as low, medium and high. For wetland rice, soil P contents of 6.0-12.0 µg g^{-1}soil are considered as low, 12.1-18.0 µg g^{-1} soil as medium and 18.0-24.0 µg g^{-1} soil as

optimum. The critical level of P by the Olsen method, which is extensively used for rice, has been considered as 8.0 µg g^{-1}soil in Bangladesh

Appreciable response of wetland rice to P fertilization is rarely observed in Bangladesh soils. On the other hand, P deficiency is considered as one of the major constraints to successful production of legumes and upland crops such as chickpea, groundnut, wheat, maize, cotton, mustard, brinjal, tomato, lady's finger etc. Significant role of phosphate application in sustaining and building up soil fertility for various upland crops is well recognized.

Potassium

Potassium is the third major plant nutrient recently identified as deficient in most Bangladesh soils. The previous idea about the sufficiency of potassium in Bangladesh soils might be true for local crop varieties with low yield potentials. One-ton wheat/ha or 2-ton rice/ha can be obtained from soils where K would be a limiting factor continuously without K fertilizers. The crop intensification with high yielding and hybrid varieties has shown widespread deficiency of potassium in Bangladesh soils on potato, sweet potato and other root crops, sugarcane, fruit, onion, garlic, fibre crops and HYV cereals. It has been recorded that a 5 ton/ha rice crop will remove more than 110 kg K which is to be made available to plants in less than 3 months time and many of our old and highly weathered soils may not have potential to supply K at this rate.

Alluvial soils of Bangladesh are rich in potash bearing minerals compared to the terraces that are older and show evidences of extensive weathering of 2:1 type minerals and potash bearing minerals. These soils may not release K fast enough to match the crop requirements especially the modern varieties to sustain yields. Potassium may also be leached and deficiency of K may become a production constraint in light sandy soils of recent alluvium with high percolation rate (72 mm/day).The critical levels of potassium for Bangladesh soils have been determined 0.09-0.18 meq/100g soil as low, 0.18-0.27 meq/100g as medium, 0.27-0.36 meq/100 g as optimum and above 0.36 meq/100 g as high.

Sulphur

Sulphur has been recognized as the fourth major nutrient limiting crop production as early as 1980. In the past very little attention was paid to this nutrient until 1977 when sulphur deficiency in wetland rice was first detected at the Bangladesh Rice Research Institute (BRRI) farm and on nearby farmers' fields (Islam 2006). Since then sulphur deficiency in Bangladesh soils is becoming widespread and acute. Variable amount of available S ranging from as low as 2 µg g^{-1} soil to as high as 75 µg g^{-1} soil has been reported.

The use of high analysis fertilizers such as urea, triple super phosphate, muriate of potash and diammonium phosphate, cultivation of modern varieties, increasing cropping intensities and limited application of organic manure have all contributed to the intensification of the S deficiency problem in Bangladesh soils. The problem is more severe in wetland rice than in upland crops as anaerobic condition, under which rice is grown, reduces sulphate and makes it unavailable to plants. Among the upland crops, oilseeds are most affected by S deficiency problems. Beneficial effects of sulphur fertilization have been observed on mungbean, blackgram and chickpea. The critical level of sulphur for Bangladesh soils has been determined as 10 $\mu g\ g^{-1}$ soil.

Calcium and Magnesium

The pH values of Bangladesh soils generally range between 5.8 and 7.0 with exception observed in acid hill soils and calcareous soils (Islam 2006). Thus, most of our soils have adequate Ca and Mg saturation on the exchange surface. Recent investigations have reflected that acid hill soils and Old Himalayan piedmont soils are extremely low in exchangeable Ca and Mg. The critical levels for these two nutrients are as 2.00 and 0.5 meq100g $^{-1}$soil. Magnesium deficiency problems have been observed on potato, cotton, sugarcane and tea grown on these soils and added Mg has brought about an appreciable increase in yields. Although Ca is also inadequate in these soils, applications of TSP and gypsum to supply P and S satisfactorily meet Ca demand of crops.

Zinc

The importance of zinc in crop nutrition has received considerable attention during eighties in Bangladesh. The incidence of zinc deficiency is widespread in most calcareous and alkaline soils. The problem is more acute in wetland rice culture.

The critical levels of available soil zinc content as established by different extracting procedures are 1 ppm for light textured soils and 2 ppm for heavy and calcareous soils.The critical level of Zn in rice plant tissue is generally considered as 20 ppm. Yield responses of rice to zinc fertilization have been well documented in different soils of Bangladesh where zinc contents were below the critical level.

Zinc sulphate (both mono and hepta) is the major source of zinc used in Bangladesh agriculture. Good quality chelated zinc is also being marketed by different companies in the country.

Boron

Although taken up in tiny quantities, boron deficiency may lead to serious consequences regarding economic yield of various crops. Boron deficiency in Bangladesh was first observed in reverine soils of Teesta on

wheat causing sterility in grains (Islam 2006). Light textured soils of the country are deficient in available boron where significant leaching loss of borate ions might have depleted soil boron level. The available boron content of the major soils of Bangladesh varies between 0.1 and 1.9 ppm. But most of the light textured soils of Rangpur, Dinajpur and terrace soils of Gazipur and hill soils of Srimangal contain low level of available B (0.1-0.3 ppm). The critical level of available soil boron used to interpret the soil test result is 0.2 ppm. However, 0.45-1.00 ppm is considered to be optimum for upland crops. Studies showed that sterility problems in wheat, chickpea and mustard grown on sandy soils of Rangpur were significantly overcome by the application of boron. The wheat yield after boron treatment was increased by more than 50% due to increased number of grains per spike. Thus, it was reported that boron deficiency might be a causative factor for sterility problems. Yields of vegetables like cauliflower, cabbage, broccoli and tomato were found to increase (14-52%) due to B fertilization.

Boric acid and solubor are the major sources of boron fertilizers used in the country.

Other Micronutrients

Other micronutrients like Fe, Mn, Cu, Mo and Cl have attracted less attention in Bangladesh crop agriculture. They are seldom needed to be applied in crop production in most soils. However, recently Cu and Mn application in Calcareous Soils have appeared to be beneficial for higher yield in some field trials. Recent studies have also indicated that Mo deficiency is widespread in cabbage, legumes like groundnut in acid soils. Appreciable yield increases of these crops in presence of added molybdenum have also been recorded. Deficiency of Cl has been detected in coconut and betelnut plants. But proper potassium fertilization with muriate of potash prevents the occurrence of Cl deficiency problems in most cases. Iron is the only micronutrient present in available form abundantly in Bangladesh soils.

Balanced Fertilization and Extension Activities

Balanced fertilization is the key to successful crop production and maintenance of good soil health. It is important to see how close nutrient addition and removal by crops match with each other. According to current statistics, the farmers of Bangladesh use 215 kg nutrients (N: 149 kg, P_2O_5: 37 kg, K_2O: 22 kg and S + Zn + B + others: 7) ha/year from chemical fertilizers, while the estimated removal is around 280 -350 kg/ha. From organic and natural sources about 50-70 kg nutrients are added to the soil system every year. One nutrient balance study made by DAE-SFFP (2002) from a typical Boro-Fallow – T. Aman cropping pattern (10 ton grain yield) is shown below:

Nutrient dynamics	N (kg/ha)	P (kg/ha)	K (kg/ha)
Nutrient uptake by the cropping pattern	180	27	180
Leaching losses from: Soil	12	-	6
Fertilizer	17	-	-
Loss from erosion	12	2	12
Gaseous losses: organic	24	-	-
N fertilizer loss	68		
Total loss	313	29	198
Fertilizer	170	25	75
Organic manure (5t/ha)	20	12	24
Incorporated crop residue	25	3	25
Nonsymbiotic fixation	10	-	-
Atmospheric fixation	8	1	2
Sedimentation/weathering	-	2	10
Iriigation water	2	6	21
Total Input	235	49	157
Balance (loss/gain)	-78	20	-41

It is quite evident from the study that severe mining of N and K are going on in the country's soil system. That's why the productivity of the soils is low and decline in crop yields has been recorded in many areas.

- To build up an optimum combination of nutrient resources based on soil test values for nutrient supply for their efficient utilization
- T avoid over-exploitation of nutrient resources
- To maintain long-term soil fertility and to prevent soil degradation

Keeping all the above objectives in view, research and demonstration on all possible combinations of chemical fertilizers, organic manures, biofertilizers and green manureing are being carried out by NARS institutes, GO/ NGOs and other agricultural development organizations under different agro-ecological zones using various crops and cropping patterns.

Extension activities on balanced fertilization have been undertaken by

various research institutes, GO/NGOs and development partners throughout the country. Technologies generated on balanced fertilization practices for different crops and cropping patterns at the various NARS institutes and also at the agricultural and general universities are transferred to the end users through various mechanisms. One of the main mechanisms is the Department of Agricultural Extension, which directly takes the technology to the farmers' fields for demonstration. Besides DAE, different NGOs directly involved in agricultural development activities also take the fertilizer use technology to the doorsteps of the farmers.

The different NARS institutes arrange training programs for extension and NGO personnel on the beneficial aspects of the balanced fertilization technology. For example, BRRI arranges training program on rice production technology in which various aspects of balanced fertilization aspects of balanced fertilization are covered. BARI organizes similar programs on its various mandated crops such as wheat, pulses, oilseeds, tuber and root crops, different summer and winter vegetables, fruits, spices and condiments, and also on farming systems where balanced fertilizer use technology is the key issue. On-Farm Research Division (OFRD) of BARI conducts research on various crops and cropping patterns as well as on farming system right in the farmers' fields and homesteads. BINA, BSRI, BJRI, BTRI and SRDI also organize training programs for the extension officers and NGO personnel for transfer of soil related technology indicating balanced fertilization.

BARC's Technology Transfer and Monitoring Unit (TTMU) serves as a vehicle in between research institutes and agricultural development agencies. TTMU also helps transfer of promising NARS institutes' technology to the farmers' fields through different projects funded by the government as well as donors and development partners. International Fertilizer Development Center has been playing a significant role in developing and disseminating fertilizer use technology in the country since long. Other important IFAD, SAIP, NW Crop Diversification and FAO/UNDP projects on food security in DAE are also making significant contribution to agricultural development in the country.

Use Efficiency of Fertilizers

Nitrogenous Fertilizers

Nitrogen is the most limiting plant nutrient in Bangladesh crop agriculture. Its use efficiency from applied urea is very low. For waterlogged rice it is as low as 25% and for upland crops it is not more than 40%. As much as 70% of nitrogen from urea is converted to gas that contributes to global warming and never reaches the plants when urea is applied to the surface .The loss of nitrogen drastically reduces the efficiency of urea fertilizer. Thus, there is a great demand to improve N use efficiency for rice as well as high N demanding upland crops.

The low level of N recovery by rice is generally caused by large losses from the soil/water/plant complex. N loss processes are ammonia volatilization, denitirfication, runoff, seepage and leaching.

Nitrogen losses through nitrate leaching can be substantial in sandy soils in drier regions. While NO_3 ions are useful for upland crops and also for rice crop at ripening stage, they may pollute underground water if leaching is severe. WHO recommends that drinking water should not contain more than 50 µg NO_3 ml^{-1}. A study conducted by BARI in the Tangail Irrigation Project showed that NO_3 contents in water of shallow and deep tube well ranged from traces to 6-7 $\mu g ml^{-1}$. The low nitrate content in irrigation water is due to denitrification processes occurring in the reduced layer of rice soils. The possibility of ground water pollution due to nitrogen fertilization hardly exists in Bangladesh soil conditions.

Ammonium fixation in soils containing illite minerals may cause unavailability of N. Besides, microbial immobilization of freshly applied N may cause temporary unavailability of N to plants. The nature and degree of losses depends upon soil and climatic conditions as well as N and floodwater management practices. The major loss processes are dependent upon the concentrations and quantity of ammoniacal N present in floodwater or at the soil-water interface in a flooded situation.

Deep placement of N in the reduced zone and proper coverage is the best method that can minimize N losses. Hand placement of urea super granules (USG) of 1-3 g into the reduced zone of the soil has resulted in smaller concentrations of N in the floodwater, less loss of N, higher N recovery and higher yield than the conventional N application practices. It has experimentally been found that minimum 30% more grain yield is possible with basal deep placement (BDP) compared to traditional split broadcast (SB) application at rates of 50-60 kg N/ha. In other words, it can be inferred that that 20-40% fertilizer N savings could occur from BDP compared to SB for production of about 800-1000 kg paddy/ha from applied N.

USG application for rice: Application of USG is made in the center of four hills at alternate two rows at a depth of 6-8 cm with two 1g granules for T Aman and T Aus rice and with three 1g granules or one 3g mega granule for Boro rice. This application is equivalent to 113 kg USG for T Aman and T Aus, and 170 kg USG for Boro rice per hectare.

USG should be applied when there will be 2-3 cm standing water in the field. After USG application the water level should be raised to 4-5 cm. One

should not enter into the rice field before one month's time. The best soils suitable for USG technology are clay, silty clay and clay loam.

Fertilizer deep placement using briquettes is labour intensive, provides high yields from less fertilizer, is environmentally friendly and feasible for use by the marginal and resource-poor farmers.

Leaf color chart: Research on site-specific N management using leaf color chart in Bangladesh is in progress at the Bangladesh Rice Research Institute (Parul 2008).

PKSMg Fertilizers

Among the phosphate, potash, sulphur and magnesium (PKSMg) fertilizers, the efficiency of added phosphate is the lowest. Only 20% of the phosphate is recovered from the freshly applied phosphate, while the rest stays in the soils. Residual effects of phosphate are visible in the succeeding crops in soils having pH values around 7.0. But in strongly acid and alkaline soils, phosphate is fixed by aluminum, iron and calcium compounds. Eutrophication (nutrient enrichment leading to excessive growth of algae) is the main reason for concern related to P losses. Phosphorus is mainly lost by surface runoff. The total loss includes P dissolved in runoff water and P adsorbed to eroded particles. Hence, heavy rainfall shortly after surface application of the fertilizer can result in substantial losses. The best options to reduce P losses would be to incorporate crop residues and apply P fertilizers into the soil.

Crops have a high K demand and uptake ranges from 50 to 300 kg K ha^{-1} per crop, similar to the uptake of N. K is added to the soil through broadcast for field crops or side/ring placement for horticultural crops. There is always a negative balance to added K indicating it is mining from the native source that is somewhat supplemented every year in flooded areas from K bearing minerals coming through floodwater. But in terrace and piedmont plains that are flood free, potassium deficiency is becoming severe. Tuber and roots crops are mostly affected by K deficiency. The principal environmental concern with K is loss of soil productivity through inadequate maintenance of K in deficient soils.

The efficiency of S fertilizers in S deficient soils seems to be satisfactory especially for sulphur loving crops such as mustard, groundnut and high yielding rice. Gypsum obtained as a byproduct from TSP factory is widely used for correcting S deficiency. Added S leaves residual effects on the succeeding crops.

The application of magnesium sulphate at the rate of 10 kg Mg/ha usually corrects magnesium deficiency in acid hill and piedmont soils. If the soil is strongly acidic, then application of dolomite is desirable to remove acidity and correct Mg deficiency. The use efficiency of magnesium fertilizers is satisfactory.

Micronutrient Fertilizers

Among the micronutrients, Zn and B deficiencies occur in calcareous and light textured soils where cropping intensity is high. The application of zinc and boron fertilizers is useful and effective in deficient soils. The addition of these micronutrient fertilizers leaves lots of residual effects in soils that can take care of two succeeding crops.

NPKS Mixed Fertilizers

The use of mixed fertilizers is convenient to fertilize the crops and there is no need to apply urea, TSP/DAP/SSP, MOP and gypsum separately. Only additional requirements of N are applied as top dressing or side dressing. The use efficiency of mixed fertilizers is higher as the nutrients in them are balanced. They increase the fertility of the soils, reduce acidity and the losses of individual nutrients as well as make soil environment more productive.

Use of Organic Manure

Organic Manure

Organic manures including cow dung, poultry manure, compost, crop residues, and green manure were traditionally and preferentially used in the country until 1950 when the chemical fertilizers were introduced through a project entitled "Rapid Soil Testing and Popularization of Chemical Fertilizers". Because of escalating prices of chemical fertilizers in the international market, organic fertilizers have once again been gaining popularity. Environmental pollution due to the use of chemical fertilizers has also become an international issue.

Therefore, all organic wastes and residues should be mobilized and recycled through composting or as raw materials for production of biogas to meet rural fuel crisis and bioslurry organic fertilizers for integration with chemical fertilizers (Islam 2006 and Islam et al. 2008). Bioslurry contains appreciable amounts of essential plant nutrients. Raw bioslurry may be used as fish feed in ponds or canals.

Biofertilizers

Use of biofertilzers in Bangladesh agriculture could not yet make any significant contribution. BARI and BINA have been experimenting with different crop specific biofertilizers since 1980. Their contribution to yield increases range from 5-15% where the native population of the microbes is low. The introduction and expansion of soybean in Noakhali and Lakhsmipur was made by MCC that supplied the inoculums from a laboratory established at Majdecourt, Noakhali. In addition to Rhizobia, there are free-living microorganisms like Azotobacter, Clostridium and Azospirilum in or on soils that can fix

atmospheric nitrogen. There is also a group of organisms known as blue - green algae that fix atmospheric nitrogen. N fixed by these organisms play a significant role in meeting the nitrogen requirement of our crop plants.

The use of phosphate solubilizing bacteria (PSB) and arbuscular mycorrhizal (AM) fungi as a technology for field application is still at the experimental stage.

Plant Growth Regulators

The farmers of Bangladesh could not harvest additional yield advantage of crops due to use of plant growth regulators, although their role in various physiological and biochemical processes is well known. However, the farmers are now convinced and have started using growth regulators for increasing crops yields.
At present, more than 60 countries have been using growth regulators/stimulants to increase yields of different crops. Growth regulators are used in small amounts that are enough to stimulate the growth. The yield increases range from 10 to 30% or even more. Different agrochemical companies are now marketing as many as 25 growth regulators in the country.

Soil Health Maintenance

Bangladesh having an ever-increasing population and limited cultivable land is forced to maximize crop yields per unit area through intensive use of land and soil resources. As a result, continuous mining of nutrients from the soil system has been going on (Islam 2009). The farmers of Bangladesh are poor and illiterate, and have tended to only exploit the soils rather than maintain them in a healthy fertile state. Soil organic matter is alarmingly low in all soil types of the country. It is generally around 1% in most and around 2% in few soils that are not conducive for high productivity.

The measures that should be taken to maintain soil health include appropriate crop rotations every alternate year in such away that rice should be at least one crop in each rotation. It is desirable to have one-grain pulse in between two cereal crops. Where time permits, green manureing crops such as sesbania, cowpea, etc may be grown for up to 50 or more days to harvest maximum biomass for soil health improvement.

Liming

Although Bangladesh is a small country, she has great diversity of soils. Except calcareous floodplain and coastal saline soils, all other soils are slightly to strongly acidic. Strongly acid soils are not productive soils. Very strongly acidic soils have been identified from acid sulphate and brown hill areas. Red soils of Madhupur and Old Himalayan Piedmont plain soils in northwestern part of Bangladesh have also been rated as strongly acidic. Because of the increasing cropping intensity and fertilizer use in the above soils during the last two decades, the acidity has gone up unexpectedly. From every harvest, the crops take up lots of calcium and magnesium. As a result, acidity in these soils is increasing day by day. For every 100 kg use of urea, 74 kg calcium carbonate is needed to reduce the acidity. During monsoon time there is some surface runoff of acidity from the soil.

Liming has many favorable functions in the soils. It increases nitrogen and phosphorus availability, makes potassium more efficient, furnishes calcium and magnesium for plant nutrition, encourages activity of beneficial bacteria and reduces the harmful effects of aluminum. Liming also improves the physical conditions of the soils by decreasing its bulk density, increasing its infiltration capacity and rate of percolation.

Standardization of Fertilizers and Fertilizer Materials

The government makes standardization of fertilizers and fertilizer materials through a gazette entitled "The Fertilizer Control Order" which is revised and published from time to time. The last gazette was published in February o6, 1999 as Fertilizer (Management) Law. There are two committees- one National Standardization Committee headed by Secretary, Ministry of Agriculture and another Technical Sub-Committee (Fertilizer) convened by Member-Director (NRM), BARC. The Technical Sub-Committee (Fertilizer) looks after any new fertilizer and fertilizer materials including feasibility, field experiment by NARS institutes and quality control by government approved five laboratories at BSTI, BARI, BINA, DU and SRDI.

The National Standardization Committee after getting recommendation from the Technical Sub-Committee approves the material for manufacture/import and use in Bangladesh agriculture. The government's approval appears in gazette notification published by the Deputy Director, Bangladesh Forms and Publication Office, Dhaka. The National Standardization Committee has so far standardized more than 80 fertilizers and fertilizer materials including plant growth regulators.

Soil Testing Services

Soil testing service in Bangladesh are weak and not satisfactory up to the standard, as one could have expected after installing all modern equipment and instruments at all the laboratories. Soil Resource Development Institute (SRDI) and the soil laboratories at the NARS institutes provide soil-testing services to the farmers at limited scale, although SRDI's 15 regional laboratories located at different parts of the country are designed to analyze at least 75000 samples of farmers a year.

The Department of Agricultural Extension with a view to providing soil-testing services to the farmers has procured 460 soils testing kits and distributed the same among 428 upazilas, 20 nurseries and 12 Agricultural Training Institutes (ATI). After initial runs with the supplied chemicals, all the kits have now become nonfunctional for want of consumable chemicals and operational funds.

Arsenic Contamination

Arsenic is one of the most abundant elements in earth's crust and occurs in Bangladesh as geological deposits in alluvial sediments at shallower depths. Arsenic poising in drinking water containing more than 0.05 mg Asl^{-1} in shallow tube wells in 59 districts out of 64 districts has been identified. To meet the growing demand for food, the farmers of Bangladesh are forced to cultivate high yielding varieties of Boro rice that require a large volume of irrigation water. Irrigation with arsenic contaminated ground water increases its concentration in soil and eventually arsenic enters the food chain through crop uptake and poses long-term risk to human health.

Fertilizer Recommendation

Fertilizer recommendations for sole crops and cropping patterns are usually made based on "The National Fertilizer Recommendation Guide" which is revised and published from time to time by the Bangladesh Agricultural Research Council in consultation with NARS scientists involved in soil fertility and fertilizer management research activities.

"Upazila Soil Use Guide" published and updated by SRDI from time to time is also a useful document for site-specific fertilizer recommendation. Each guide has at least 100-150 site-specific information on soils nutrient status, topography, hydrology, vegetation and drought.

Fertilizer recommendations are usually made on the basis of soil fertility classes; yield goals and farmers' management ability. For high yield goal fertilizer recommendation, one should have site-specific information on nutrient status of soils as well as the crops. If the site-specific information on the soils are not available, moderate yield target may be fixed and the information available for agro-ecological region in the guide may be used to determine the fertilizer doses.

Conclusions and Recommendations

Because of the different complaints being heard and seen through electronic media such as TV and BBC dialogue on Bangladesh as well as print media like different dailies, weeklies and fortnightlies, the government should initiate and encourage free marketing of fertilizers just like other essential commodities such as rice grain, common salt, edible oil, kerosene, etc on a pilot scale in some selected upazilas. On the basis of successful observations, the free marketing of fertilizers may be expanded all over the country.

It is very important that timely supply and availability of fertilizers at reasonable prices at the doorsteps of

the hard working farmers in the country can only ensure balanced fertilization that is very much needed

for our depleted soils for optimum supply of nutrients for sustainable crop production and maintenance of soil health. The supply of nutrients to the soil – plant system comes from various sources, the most important sources being the organic manures and chemical fertilizers (Fig. 2).
or underuse/sometimes overuse resulting in huge wastage which the country cannot afford. Therefore, the

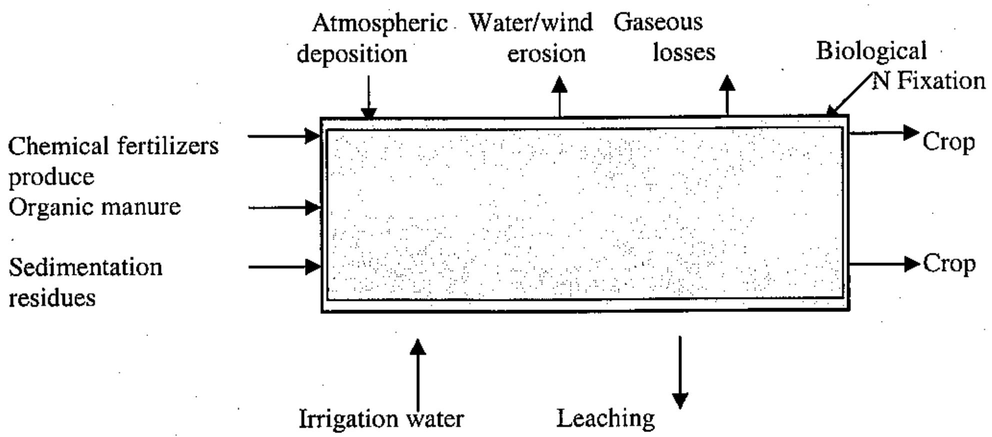


Fig. 2. Soil-plant system.

At present more than 4 million tons of chemical fertilizers worth more than Tk 7000.00 crores (US $ 1000.00 millions) are being used along with 70 million tons of organic manures in Bangladesh. The use efficiency of the chemical fertilizers is low and unsatisfactory because of imbalanced practice of balanced fertilization should receive top priority to increase sustain & crop productivity when food security is so crucial for poverty stricken people, the country is facing challenges of increasing population and shrinking natural resources including agricultural land and when there exists big gap between poential and farmer's yield.

References

BCIC. 2008. Bangladesh Chemical Industries Corporation, Ministry of Industry and Commerce, Government of Bangladesh.

DAE-SFFP. 2002. Seminar on Soil Health Management: Department of Agricultural Extension-Soil Fertility and Fertilizer Project Experience.

Islam M S. 2006. Soil Fertility Issues in Bangladesh, EU Food Security Identification and Formulation Mission, Dhaka, Bangladesh.

Islam M S. 2009. Challenges for Nutrient Management in Bangladesh. Proceedings of IPI- OUAT-IPN International Symposium on Potassium Role and Benefits in Improving Nutrient Management for Food Production and Reduced Environmental Damages, Bhubaneswar, Orissa, India.

Islam M.S., M.S. Khan, R. Sen, K.M. Hossain, S. Noor and M.S. Islam. 2008. Effect of Grameen Shakti Jaibo Sar on the yield and yield components of tomato. Bangladesh J. Agric. Environ. 4(2):1-9.

Khan M. S., N.C. Shil, and S. Noor. 2008. Integrated nutrient management for sustainable yield of major vegetable crops in Bangladesh. Bangladesh J. Agric. Environ. 4:81-94. Special Issue, 2008.

MoA. 2009. Ministry of Agriculture, Government of the People's Republic of Bangladesh.

Parul S. A. 2008. Determination of optimum N-dose of BRRI dhan29 using Leaf Color Chart- PhD Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Strategic Decisions in Transforming Subsistence to Commercial Agriculture in Bangladesh

M. Hassanullah [1]

Abstract

As a nation we need to make some strategic decisions to realize potentials of agriculture which is, on an average, approximately three times more than the present levels of productivity, if we wish to realize our dream of becoming a middle income country within a reasonable span of time. The emerging socio-economic conditions of consumerism in domestic market and unrestricted global movement of goods and services created market opportunities for realizing the potentials profitably Therefore, as a basic policy, we need to transform our subsistence agriculture to a vibrating commercial one and sustain it over time. It requires adopting some strategic decisions related to 1) preservation and upgradation of agricultural resources which requires adoption of upazila based legally protected land use plan, adoption of a national soil fertility regeneration program, removal of brick fields from crop (rice) lands and banning discharge of untreated waste to water resources; 2) production strategies which requires adoption of a rolling assessment of supply & demand, deciding becoming commodity-wise self reliant and partially self reliant and import dependence, and adoption of crop zoning, 3) technology generation & transfer which requires an emphasis on basic research, decentralization of applied research activities, promotion of private sector research initiatives, a decentralized and integrated extension system, and introduction of a chartered extension system; 4) food security & safety which demands identification, development and protection of rice lands and an integrated program of production and procurement of rice, 5) input and service providers' capacity which requires transforming BADC as Agribusiness Development Trust and adoption of a regulatory framework for quality inputs and services; 6 innovative marketing systems requires supporting farmer groups, traders and processors establishing contract production and supply systems and establishment of agro-export and processing zones, 7 market and marketing system reform which requires creation of needed market space, an unified market ownership & management system, planned market infrastructure, a permanent revenue collection system, and change of regulatory system for stopping taking over. agricultural markets and protecting interests of producers, traders and consumers; 8) climate change which requires adoption of an agro-meteorological extension service and 9 human resource development which requires revision of curriculum for producing managers of commercial agriculture, an expansion of domestic facilities for post graduate studies, and adopting a massive and subsidized diploma education for future farmers. This paper explains the logics of making those decisions and how those are to be implemented in the shortest possible time.

*Independent Consultant

Introduction

The proposed decisions are termed as strategic decisions as these are in contrast to conventional line of thinking and have long term impact in agriculture. Before presenting the strategic decisions, the changing socio-economic conditions of the country, implications of living in a global village, potentials of Bangladesh agriculture, and the need for realizing & expanding the potentials were briefly reviewed which led to make the strategic decisions with concrete programs for implementation

Changing Socio-Economic Conditions

In not so far distant ago farmers were not so much responsive to new technologies to increase production. Society was also not ready to consume increased production and global market was also not accessible. As a result, increased production of any commodity created miseries of producers due to seasonal gluts. Recently, tremendous socio-economic changes occurred paving the way for harnessing the potential of agriculture which has so far remained hidden. Awareness about opportunities and constraints has increased tremendously. People are now doing whatever they can do and have broken the seasonality of many crops. In every region farmers and entrepreneurs are exhibiting high levels of achievement motivation. There are many success stories not only among rich farmers but also the poor and ultrapoors. A very positive attitude has developed among people to accept changes not only in production process but also in life style and habits. Mobility has increased tremendously which is obvious from the intensity of plying buses, cars and trucks. One can reach any corner of the country within a time span of 6-7 hours. Commercialism has begun in many places. Many examples can be cited e.g. late tomato in Dinajpur, bitter gourd in Akkelpur, beans in Muladuly, etc. etc. (Practical Action, 2007). Privatization is now an accepted way of transecting goods and services. Farmers are demanding availability of inputs and services in open market so that they can instantly buy or sell. Consumerism has been developing rapidly. High priced fruits and vegetables are extensively sold in ordinary street corners and roadside rural markets. Indigenous products which were once neglected has become high value products occupying shelves of super markets (Minten, et al 2010). Domestic market is ready to absorb high volume of commodities if merchandised properly. Globalization has also increased. High quality exportable items are packed and shipped abroad directly from the production centre even without coming to local markets. The emerging socio-economic condition is now highly conducive to increased production of quality products if marketing is properly organized.

Living in a Global Village

It is nice to hear that we are increasingly living is a global village. Many feel proud of status, mobility, freedom of movement and globalization of rights and privileges of people, while many are afraid of losing markets of both human and materials resources. In recent past our per capita income has increased to US $ 690.00 (BBS Website, 2010) which has created affluent strata of consumers creating demand of high quality products and services. To meet the increased demands there is a high tide of goods and services of not only consumer goods but also fresh and processed agri-foods even from advanced countries. Being a food deficient country, we are already importing staples at very high prices; often sales are denied to our country. It is not unlikely that our producers being not competitive will loose their own domestic market. Living in a global market, therefore, needs to be more productive compared to our competitors. We must raise productivity, quality and safety of products even for our own domestic market, lower cost of production and processing. Many of our industrially important products like jute and sugar are losing global and domestic market due to illogically high processing costs and quality deterioration. To be more productive and competitive we need to acquire knowledge & skills of universal standards. We must be extremely vigilant and sensitive to socio-economic changes occurring anywhere in the world and become highly proactive to make strategic decisions in order to adjust and control both favorable and unfavorable events and phenomena particularly in the agriculture sector which sustains our livelihood.

Subsistence Vs Commercial Agriculture

Subsistence agriculture signifies production for consumption (100%) either at household or at national levels originated from Gandhinian Movement of achieving self reliance which was further enforced by Swanirvar Movement to face the challenges of famine like situation in early seventies. The strategy of subsistence agriculture of growing everything everywhere followed by advocacy of processing everything at home for household consumption is neither technically nor commercially viable as a business proposition. It satisfies the taste of producers and the concept of labor intensity to keep family labor engaged in low productive and un-remunerative ventures. On the other hand, commercialization signifies production for sales (100%). The term commercial agriculture was first boldly tossed in the National Convention of Krishibeed Institution in 1997 which was severely criticized in the mass media (Hassanullah, 1999). It produces agro-climatically

suitable area specific products with high levels of capital intensity resulting in high productivity. Transformation of subsistence to commercial agriculture can only make agriculture competitive in the context of globalization and domestic consumerism.

The very nature of commercial agriculture demands high investment in a situation of high risks. It is market oriented to justify the investments. It demands skilled management with high levels of instrumentation with flexibility and adjustability with change. Commercial agriculture can play very powerful roles of technology generation, acquisition or buying and marketing or transfer because of profit motive.

Potential of Bangladesh Agriculture

It is obvious from the size and appearance of imported commodities as displayed in the market places that our agriculture is far less productive than our competitors. Average yields of rice and wheat of different countries as in **Table 1** testifies that our productivity is far below than both developed and many of the developing countries. The difference is likely to be significantly much wider in case of fruits, vegetables, spices and pulses as well as meat, milk and eggs.

Table 1: Comparative yield of rice and wheat of Bangladesh

Countries	Rice (Kg/Ha)	Countries	Wheat (Kg/Ha)
World	4156	World	2791
Egypt	9972	Belgium	7418
Australia	8150	Ireland	8114
Turkey	8058	Netherlands	7071
USA	8053	New Zealand	6875
China	6341	UK	7341
Bangladesh	3884	India	2671
India	3207	Bangladesh	2056

(Source: FAOSTAT 2007)

With these levels of yields we can neither be self sufficient nor competitive in the world market. . Therefore, on rush of imported commodities will continue. But we have suitable climate to become an exportable country. This calls for basic research to alter genetic materials and improve the production processes of plants and animals.

Besides comparatively low productivity, our farmers are also exploiting only about half of the production potentials of available plant and animal breeds. **Table 2** indicates that we are exploiting about half of the production potentials of rice and wheat. This gap is even much wider in case of fruits, vegetables, spices and animal and fish products.

Table 2: Extend of exploitation of production potentials of rice and wheat *

Levels of Potential	Rice (Boro) (Tons/Acre)	% of TP	Wheat (Ton/Acre)	% of TP
Average yield achieved	2.68	48	1.66	54
Achievable potential	3.80	68	2.08	68
Technical potential	5.58	100	3.08	100
Genetic potential	Not known		Not known	

** Note: Author's own calculation based on available data. Achievable potential means results of demonstration and Technical potential is the yield expected by Scientists when recommending a variety.*

Need for Strategic Decisions

We need to make some strategic decisions to shift from the policy of providing subsistence of people to engage in commercial agriculture in order to exploit the production potential of agriculture. Anybody when associated with commercial agriculture either as labor or entrepreneur was found to have higher income as compared to subsistence agriculture. This is because the fact that scope of value addition in subsistence agriculture is very low. As a result, entrepreneurs can pay little to all those who are associated with production processes. We need to exploit the potential because there are global demands of all agro-products and we can exploit it highly profitably if and when domestic and global marketing are organized. Failure to exploit the potential leads to unrecoverable perpetual loss of production. It is of utmost necessity because the country is under constant risk of food insecurity. Besides, we desire to transform the country as middle income country within the next decade and also committed to build sonar Bangla (Golden Bangla)on a long term perspective.

Areas of Strategic Decisions

The key areas of strategic decision are as follows:

1. Preservation and up-gradation of agricultural resources
2. Production strategies
3. Technology generation & transfer
4. Food safety & security
5. Input and service providers capacity
6. Innovative marketing systems
7. Agriculture markets reform
8. Climate change
9. Human resource development

Preservation and Up-gradation of Agricultural Resources

It is needless to mention how valuable land, water and air are for long term sustainability of agricultural production and quality & safety of products (Islam, 2000). It is now nationally recognized and well reported in mass media that one percent of land is going out of cultivation every year, that organic matter and many of the plant nutrients have dwindled down to below the critical levels, that water and air is increasingly polluted to the extent that is creating bio-physical imbalance in soil, water, and air affecting productivity, quality and safety of agro-products. In order to protect the basic resources of agriculture for long term sustainability, security and safety of our livelihood **firstly** we need to adopt upazila based land use plans adopted and protected by law earmarking lands for (a) agriculture, (b) industrial & commercial use, (c) residential, (d) graveyard in the very cadastral maps and authorizing a legal body to appropriate and re-appropriate lands for different uses depending on local contingencies. **Secondly**, we need to undertake a nation-wide soil fertility regeneration program adopting multiple methods and techniques as needed in specific areas and regions on a fairly longer period of time including infrastructure of irrigation & water control structure, increasing water holding capacity, waste recycling, cropping pattern change, cultivation practices, etc. **Thirdly**, on a long term perspective we need to ban brick manufacturing by adopting iron structure and sand cement blocks as building materials or recycling emitted gas back to burning process or to some alternate uses. Alternately, at least relocate the brickfields outside agriculture land in general or rice land in particular immediately. **Fourthly,** we need to ban on discharge of untreated industrial and municipal waste to water resources giving 2-3 years lead time to allow adjustment or installation of the system of affluent treatments.

Production Strategies

Production strategies are very important to match commodity-wise supply and demand to avert emergence of hopeless situation of markets as we are witnessing time and again. This situation is not desirable and should be changed. **Firstly** we need a permanent institutional base or system of making commodity-wise reliable rolling assessment of demand and supply, not a calculation of physiological needs of nutrients, to avert supply disaster or disorders. **Secondly** based on assessment of supply and demand we need to decide commodity wise self reliance, partially self reliance and import dependence depending on agro-ecological and economic comparative advantages with specific production and import targets well ahead of time so as to cope with the problem of lead time required for production and import as well. **Thirdly**, we need to adopt crop/product zoning based on agro-ecological suitability which ensures highest probability of maximizing productivity and quality of products with minimal cost of production. When such zones are established, it will be easy to establish product specific inputs, logistic, infrastructure, transportation, and storage. Establishment of specific crop/product zone does not imply that farmers have to grow only that specific crops/product. It implies that no institution will introduce any competitive crop development or support any organization as policy to introduce any competitive crop/product rather design and promote specific crop based cropping patterns to ensure production of the principal crops. Farmers will have freedom of cultivating any crop but will eventually feel discouraged when institutional support will not be available.

Technology Generation & Transfer

There is no limit of human aspiration of growth and development. This unlimited aspiration of people can only be realized through continuous generation & transfer of more and more productive technologies. There is no alternative of serious research and technology transfer system as technologies generated in another country or society are patented or restricted or even banned for transfer or sales to another society or country. We have an elaborate system of technology generation & transfer. **Firstly,** to keep the system efficient and effective we need to assign the highest emphasis on basic research without which breakthrough in productivity can not be achieved. Our national agricultural research institutes need to be supported with human and capital resources to conduct basic researches to overcome barriers of productivity and seasonality, processing, storage and preservation in agriculture sector. **Secondly,** To accommodate more basic research the national institutes should decentralize applied research activities to regional institutions and universities in order to generate and disseminate region specific technologies and replenish academic curriculum with new local knowledge and experiences. **Thirdly**, we should create a fund to support the growth and development of private sector corporate

research initiatives since a good number of large enterprises in processing and seeds have emerged who are relentlessly trying for product development to remain competitive and profitable in the global market. It has been observed that corporate research is often much more business- oriented and creditable than public sector research. Commercial agriculture demands rapid transfer of technologies particularly for growth and development of micro and small enterprises of production, processing and marketing. A decentralized and integrated extension system can meet this demand. We, therefore, **fourthly,** we need to re-design, develop and install a decentralized and integrated extension system (crop, livestock, forest and fisheries) accountable to the farmers through local government representatives. Such a system always creates greater opportunities for professional development and activities. This way credibility and reputation of extension system would increase tremendously. A new phenomenon of providing extension services are rapidly developing. As the commercial production is increasing the entrepreneurs are turning to private service providers. International agencies are also promoting growth of private service providers. In some places private service providers have formed their associations providers. Often they are neither capable nor accountable to giving services as farmers demand. Often they are neither capable nor accountable to the service receivers. We, therefore, **fifthly,** we should establish a legal system of creation, promotion, control and protection of a Chartered Extension System. The legal system includes a recognized authority of conducting qualifying examinations for private extension agent or service providers, register qualified persons as Chartered Extension Agents, formed them as an association, link them with NARS and support them to be scientifically equipped to render services effectively and set operational standards with a system of arbitration if any conflict arises.

Food Security & Safety

Food security is now an international concern despite a dozen of projects/programs of national and international agencies have been implemented in recent past. In the backdrop of climate change, the problem of food security is assumed to be even more acute (Asaduzzaman, et. al., 2010). Nationally, we have been trying to combat the challenge through international and regional cooperation and management of safety store nationally and regionally, etc. But to me nothing can compensate the strength of "domestic food production" of a country in which food (cereals, vegetables and fruits) production can be increased manifold with relatively very little investments. In this backdrop we should **firstly,** engage in identification, development and protection of rice lands, as rice is the staple constituting 90% of diet of an ordinary person. If rice is available majority people will find recipes to eat a bowl of rice in order to prevent hunger. We are now noticing that prime rice lands are converted for brick fields, fish ponds and real estates. Further, their fertility is depleting due to intensity of rice cultivation, water erosion, and top soil sales for brick manufacturing. All those activities need to be stopped. It should be mentioned here that China has reserved 120 million hectare of land creating what they call permanent rice base. In Bangladesh, the inland basins what is commonly known and marked in cadastral maps as *Dola Lands* are the rice lands which are scatteredly located in all agro-ecological zones of Bangladesh. Once rice lands are identified, we should, **secondly,** undertake a national program of integrated production and procurement of rice directly from the farmers which we talked many a time but could not install the system on a continuing basis. Such program should be organized jointly by Department of Food, Extension and Marketing to organize all farmers of selected *Dolas* under contractual arrangement with farmers, input & service providers, financiers, millers for production, processing and procurement of rice. This is done in Japan and is now being done by China.

Input and Service Providers Capacity

Commercial agriculture demands high quality inputs (seeds, fertilizers, pesticides, chicks, feeds, calves, medicines, machinery repairing and servicing, etc.). Private sector inputs and services providers at this stage are not yet guided or controlled neither by effective regulatory framework nor by moral and social values and corporate responsibilities. As a result, growth of commercial agriculture is stumbling due to poor quality and adulterated inputs and services. BADC can still play these roles commercially as recommended by Iqbal Mahmud's report on BADC restructuring (Mahmud, et. al 1993). We therefore, **firstly** need to transform the BADC as "Agribusiness Development Trust" based on the principles laid down by the committee . Still the government can outsource the services of the trust to perform any philanthropic work as and when needed by the government on paying the cost of services. This will help proper use the vast public property and resources of BADC developed over a long time. **Secondly**, we should establish a regulatory framework to ensure quality of inputs sold by the private sector organizations and protect the interest of farmers through arbitration and compensatory measures at Upazila and district levels.

Innovative Marketing Systems

With the increase of non-farm consumers of domestic and global markets, a very long marketing chain has been traditionally developed involving as many as 6 tiers of traders (foreya, paikers, aratders, suppliers, wholesalers and retailers) to bring produces from every nook and corner of the country to the non-farm consumers of the cities and urban centers. In the process, a few service providers also take a share such as local transport providers, labors for loading & loading, weighing, packaging/sacking, truck arranging agents, truck owners, auctioneers, etc). Experts often rebuke and abuse them as suckers but did not try to establish alternate systems of marketing agri-products reducing the role of intermediaries. The government **firstly** should support the corporate buyers such as processors, exporters, super

markets, consumer cooperatives even wholesalers to establish long term contractual buying and selling arrangements with corporate sellers viz. producer groups and associations wherever possible. Once the system is established and becomes beneficial to both buyers and sellers it will be rapidly replicated in different locations for different commodities. **Secondly**, we should establish agro-export and processing zones in exportable product/commodity zones and assist corporate buyers to buy directly from producers by opening merchandizing and processing industries in the very heart of production zones through incentives and tax rebates. The Agro Processing & Export Zones will provide easy opportunities for:

- Ensuring standards & qualities of raw materials
- Establishment of traceability system
- Introduction of GAP
- Effective management of incentives
- Ensuring standards & qualities of finished products
- Waste & cost reduction
- Development of infrastructure and facilities
- Contract management

These are essential requirements of promoting export as well as serving domestic super markets.

Market and Market Management

There are over 15,000 agricultural markets in the country. The number of assembly markets is over 2000. The assembly markets play significant role in setting commodity prices which fluctuates highly depending upon seasonality as well as influence of syndicates of foreyas, paikers, commission agents and wholesalers. The dismal performance of the agricultural markets is well known and widely reported in mass media. Markets, in fact, defied all efforts of government to stabilize prices. Nothing will improve unless 5 basic problems of agricultural markets across the country are solved viz. highly inadequate space, multiple ownership, unplanned and inappropriate infrastructure, exploitative revenue collection system, taking over possession of markets by public bodies. The so-called regulated markets taken over by the Department of Agricultural Marketing under the authority of Market Regulation Act, 1982 could not bring any improvements or could not solve any of the basic problems of markets and improve their operation and management. We talked much about markets but did in fact very little. **Firstly**, we need to decide for creating of adequate & defined space in the cadastral map for a market and restrict alternate use by law. Markets established many years ago on a piece of public land which was gradually appropriated by powerful individuals either informally or formally. Over the years transactions increased manifold but space reduced forcing the market split and locate different sections in many different places. If creation of new space is not possible alternate area should be selected for a second market. Adequate space is determined by volume of transactions of goods and services by class and an additional space required for expansion for at least next 30 years. **Secondly**, we should establish a unified ownership and establish a market management authority for each market by law representing all groups of market operators by periodic election. Different parts a of market sit on lands owned by different agencies and individuals viz. Land Revenue Department, Railway, Road and Highway Department, etc each exercises its own authority and has its own system of revenue collection and management, though government, in general, auctions yearly to collect revenue. Unified authority and ownership will not hamper their revenue collection interest if revenue earned is apportioned to land owners based on proportion of land they own. Once market is defined and ownership established, we should **thirdly**, plan the markets as a) assembly section, b) wholesale section and c) retail section. Plots of wholesale and retail sections should be allocated on a long term lease to individual operators while government will simply construct a large open shade for assembly section with path ways and common services. Lease holders will construct their shades at their own costs using a standard designs. **Fourthly,** since market spaces are allocated on a long term lease, we should introduce a permanent & unified system of market revenue collection through banks on a monthly basis and the money thus collected could be apportioned as per government policy of distributing revenue to different agencies or owners of land resources. The scavenging sellers sitting in the road side places should be exempted from any marketing charges. **Fifthly,** government should stop taking possession of agricultural markets for revenue collection and the relevant ordinances should be restructured and upgraded to incorporate all the above provisions

Climate Change

Everybody is now aware that climatic hazards of flood, cyclone, storm, hail storm, excessive rain, heat spell, cold spell, heat and humidity are fluctuating, sometimes severely and the farmers become hopeless to deal with their productive activities before, during and after such situation. The entrepreneurs of commercial agriculture suffer the most as it involves very high investments. To assist the farmers to deal with such situation we should **immediately** introduce an Agro-Meteorological Extension Service (AMES). The AMES is not a field organization like DAE but a cell, a section or division within the framework of DAE staffed with multidisciplinary team of experts under a capable leadership who will be engaged in the collection of information, forecasting, preparing extension service modules (a package of programs), communication of the package to the users through all alternative channels of communication and follow up & get feedback from the

system. An extension service modules constitutes a television discussion, radio discussion, a video, songs (folk), a folder/leaflet, miking, hosting danger signal, etc

Human Resource Development

Human beings are the prime mover of an economy, a sector or a product. Commercial agriculture demands a very high level of skilled managers and technologists who can transform a dream to a profitable business. The academic curriculum of existing educational institutions does not produce appropriately and adequately qualified persons required for commercial agriculture. In many cases general BBAs and MBAs are engaged to run agribusiness enterprises. An appropriate curriculum combines both management and agricultural sciences in appropriate proportion. The **universities** need to review and revise agricultural curricula for producing appropriate managers and technologists of commercial agriculture by combining both management and agricultural sciences in an appropriate proportion. **Secondly**, we should support the universities to expand domestic facilities for post graduate studies in order to prepare people of higher levels of specialization at post graduate level in various agribusiness trades. **Thirdly,** the government should develop a program to support public and private agricultural diploma institutions to administer a massive diploma education for preparing future commercial farmers with a combined curriculum of agriculture sciences and business management.

Concluding Remarks

Unrealized production potentials are lost forever. If potentials are realized Bangladesh will be able to feed many countries over and above being self reliant in agricultural products. If critical issues are continued to be ignored, the country may be heading toward points of no return. "Better Late than Never". Let our leaders and policy planners rethink about the issues discussed here.

References

Asaduzzaman, M. ; Claudia Ringler, James Thurlow, Shafiqual Alam. (2010). Investing in Crop Agriculture in Bangladesh for Higher Growth and Productivity and Adaptation to Climate Change. Paper presented in Bangladesh Food Security Investment Forum, May, 26-27, Dhaka.

BBS (2010). National Income, BBS Website.

FAO, (2007) FAOSTAT, FAO Webesite.

Hassanullah, (1997). Agribusiness Development: a Key to Meeting the Challenges of Twenty First Century Agriculture. A paper presented in the National Convention of Krishibeed Institution, Dhaka.

Hassanullah, (1999). Potentials of Commercial Agriculture in Bangladesh.. Website; http://www.agrobengal.org/special/PotComAgr.htm.

Islam, Z. (2000). Land Use Pattern in Bangladesh and Future Food Production Challenges: Are We Heading Towards a Disaster. In: Bangladesh Environment 2000, BAPA, Ed. M. Feroze Ahmed, Dkaka.

Mahmud, Iqbal, Khalid Shams, M. Hassanullah, (1993). Restructuring of BADC, a Report of an Expert Team, March, 1993, Dhaka

Minten, Bart, Ikram Ahmed, A.Z.M. Shafiqul Alam, Uttam K. Dev, David Laborde, M. Hassanullah, K.A.S. Murshid. (2010). Agricultural Marketing, Price Stabilization, Value Chain, And Global/Regional Trade. Paper presented in Bangladesh Food Security Investment Forum, May, 26-27, Dhaka.

Practical Action, (2007). Mid-term Review of Facilitation of Marketing Services Project (FMSP) is a support project of Microfinance for Marginal and Small Farmers Project (MFMSFP). IFAD & PKSF, January, 2007, Dhaka

Human Follies for Progress and the Endangered Environment: Pointers to the Policy Planners

Kazi M. Badruddoza[1] and F. M. Maniruzzaman[2],

1. Whither Progress ?

Where are the placid landscapes of our childhood? Where are the forests full of birds and different animal species? Where is the silence in our countryside? Where are the flowers we gathered near stream waters when we were children? We have poisoned the air, the water and the land. In our passion to dominate nature, things have gone out of control. Progress from now on has to mean something different if we want to avoid disaster. We cannot contime using one place and moving on to the next because our country is small to accommodate the increasing human ocean. We are running out of cultivable land at the rate of 1% per year and national resources at and alarming rate.

2. Transformation of Dhaka

Our own involvement on the destination of nature started before we knew it, growing in our village home and latter in Dhaka. The places were beautiful then having few people moving around. We watched for nearly last sixty years the green open spaces turning into concrete houses, markets and paved roads; and the clean air into poisonous air. In 1950's and even early 60's, the road from New Market to Kalynpur was semi-paved surrounding Nilkhet, Elephant road, Green road, Kalabagan, Dhanmondi, Sobhanhag, Lalmatia, Mohammadpur, 500 acres Dhaka farm, Agargaon and Shamoly. The Dhanmondi residential area started coming in to shape from early 1960's. The road from Kalynpur connecting different sections of Mirpur rarely existed. Most of the places were barren, scattered ponds, ditches and rice fields. Most of the settlers in Mirpur area were from Bihar in India after Indo-Pakistan partition took place. The present day Paikpara, Pirerbag, Monipur, Sewrapara were unimportant habitations of people mostly coming from other district of the Country. The Progoti Sharani passing through Kazipara- Shewrapara connecting Mirpur with Agargaon came into existence only thirty years back from now.

The present Sangsad Bhaban, Khejurbagan, Zia's graveyard, Khamarbari, Bangabandhu-China Maitri Hall, Chandrima Uddyan, Election Commission-Planning Commission Building Complex and Suhrawardi Hospital-Medical College were our 500 acres Dhaka farm. Mohammadpur, Shyamoli, Baitul Aman, Pisciculture and adjoining different present day housing societies

[1]National Scientist Emeritus, N A R S-B,
[2]Former Chief Arboriculture, Ministry of Communication, GOB

came into existence within the last 40 years from now.

The Dhaka cantonment was isolated but linked by a narrow paved road with Tejgaon old Airport. The road connecting Jatrabari, Syedabad upto Kuril-Nikunja was narrow, semi-paved and almost free from transport congestion even twenty five years back from now. Road from Tejgon Industrial Area connecting Dhaka Tongi-Diversion road was poor and narrow passing through Uttara Model Town which was barren with vast rice field till early 1970's. After the commission of International Airport in early 80's only a few vehicular traffic were visible.

The places where there were little or no human babitations before 50 years from now such as Khilkhet, Kuril, Basundhara, Baridhara, Badda, Kalachandpur, Rampura, Malibagh, Khilgaon, Chaudhuripa, Mawchak, Rajarbagh and even Shantinagar-Baily Road and adjacent areas have turned into congested concrete buildings, jam-packed roads full of transports and human waves.

The prestigious Gulshan-Banani residential area came into existence during early 1960s and Baridhara Diplomatic zone occupied its prestigious status in early 1980s. If we turn our eyes to Dhaka University, the present arts and commerce faculties were accommodated in muti-storied buildings east to Dhaka Medical College about 55 years from now. The vast area west to Dhaka race course (Sharawardi Uddan) extending up to Babupura- Kataban now occupies a place of higher education in arts, commerce and business administration of Dhaka University along with school of fine arts and Dhaka Museum. The New Market, Balaka Cinema Hall, Gawsiya-Chandichak, Dhaka college, Teacher's training college started coming into existence after early 1950s.

Out of nearly 50 private universities, all of which started functioning within the last 18 years, almost more than two third are accommodated in Dhaka city residential areas excepting a very few having own campus. So, we can see the scenario is completely different from the past half a century.

3. What Kind of Progress

Like most people in our generation, we were brought to believe in progress. We still do. But now we are at a point where we have to ask ourselves if we are the beneficiaries of our progress or victims. We have extended our civilized society, modern buildings up to Joydebpur-Razendrapur in the north, up to Savar-Ashulia-Kaliakayr in the west, beyond prestigious and historically important Buriganga River in the south and up to Meghna Bridge in the east, heading from Syedabad, Jatrabari, DND and Kanchpur. We have recently connected Narayanganj – Narsinghdi through Dhaka by-pass up to Joydebpur and even further to the

country's northern areas connecting Chittagong port. We are also having a satellite modern town 'Purbachal' from Narayanganj to Joydebpur to accomidate vast human habitations. If we extend our eyes beyond Dhaka, we see the same change in every Division, District and Upazilla. Our population now approximates 160 million, which was 35 million fifty years ago. Not to speak of the earth, the land of our parents and ours are at risk as never before because of over population, indiscriminate exploitation of our limited natural resources and expanded comfortable living habits

World's leading scientists and environmental experts have provided an overview of the continuing pressures on our ecosystem due to over population of the country. of ours. Scientists tell us that by the next century. the environmental struggles will be lost, by that time it may be too late to repair. We must bear in mind that we cannot continue to satisfy our own needs, at the expense of those of future generations. As a policy option, population control should be the number one programme for the country.

Downstream flooding is the consequence in Bangladesh where most of the country's are goes under water, beginning from 1954 then several times up to 1988 when half of the country was totally sub-merged for nearly three weeks including almost half of Dhaka city. And this has been occurring more frequently in recent times. The losses of wealth, animals, plants and human life in the floods of 1998, 2003 and 2007 were enormous, not to speak of the catastrophic cyclonic storms and tidal waves in 1970, 1991, 1994 and 2007. According to the best guess of the Inter-Governmental Panel of Climate Change, the global average temperature is likely to rise at least 1C by the year 2050 due to global warming. As a result, sea level will rise from anywhere between 4 inches and 6 feet (ten centimeters and two meters), low-lying coastal areas would be wiped off the map. A sea level rise of 3 feet (1 meter) would flood 770 square miles of low-lying coastal Bangladesh, which is desperately impoverished and overpopulated. The overpopulated capital, Dhaka city is being threatened almost every year by water logging, flood, contamination of drinking water and water scarcity. The same condition prevails in almost all the Divisional and District towns of the country.

4. The options left for us

The publication of Bruntland Report, "Our Common Future" in 1987, first brought the world attention to the fundamental concepts of Sustainable Development and Save the World. Since then, the Rio conference in 1992 and many other national and international fora related to the world environment took place and are being continued till to-day. Awareness is, perhaps, no longer the issue. Even our children know more about environment than their parents do. This is obviously good. But the problem lies with the leadership and their advisers. No Worthwhile ameliorative measure has been taken up to reduce the destructive onslaught of the ecologically unsuitable development plants.

The most important step we can take is to send a clear message to our leaders and planners that we are almost at the point of no return. The leaders must learn to shoulder the responsibilities of protecting the environment without delay and forcefully, if needed. Since Bangladesh came into being in 1971, the national highways extended from east to west, north to south, but through the process, the wetlands have been disrupted and wetland bio-diversity has been shattered. The concept of sustainable development and environment impact assessment came lately, though sometimes altered by motivated powers as and when wished. This represents an astonishing lack of both vision and common sense. Most of the technologies that will ensure a dignified and secure future for each and every one of us are already in existence or are being developed. We should listen to what is being said and do the best for the betterment of the future..

Our country's land and water as well as food are under constant pressure from a growing population. Over the last four decades demand for food has nearly tripled due to population growth and rising affluence. This rising demand for food has forced the farmers to use inorganic fertilizers and pesticides indiscriminately. We are already paying for some of the ecological costs of imposing western-style intensive agriculture which is inappropriate since we do not home spareable land.

Some senior agricultural scientists hope to boost up crop yields through genetic engineering, but to achieve this we need talented scientists, physical facilities and modest investment. Intensive agricultural production have also lowered down the water table in almost all parts of the country which necessitates development of drought and saline resistant food crop varieties. The government has not yet taken any meaningful step to provide required facilities for this important program. Agricultural Research should get preferential scope and meritorious the scientists should be engaged and retained by providing appropriate physical and financial incentives. About 450 scientists have emigrated to developed countries due to lack of incentives and career development prospects.

Forest areas are declining mainly as a result of over population and indiscriminate felling of trees. The responsibility for this lies largely with the government who fail to promote land reform and sustainable agricultural practices as an alternative to forest clearance.

The flowers we grow in the garden, the fruits and vegetables that we eat were all originally derived from wild species. The government must, therefore, place utmost priority on natural forest conservation. And the government for the sake of the country must declare deforestation a national emergency. Strict observation of plantation campaign will not benefit the nation unless millions of saplings planted every year are managed and kept alive. Groups of plant species must be selected for plantation along different roads and besides waterways to facilitate conservation of bio-diversity. We should be aware that extinction of one plant species could cause extinctions of about 30 other dependent species / organisms necessary to maintain ecological balance.

The population explosion has already happened. We must fix the clock now to maintain a stable population by reducing the birth rate to equal the death rate. Meeting the growing demand for education and family planning among both men and women can help this. The preferred model is the nuclear family with two children, which results in a stable population. The concept of one child in one family is the best. To ensure this concept monetary award should be introduced at all levels of the society. The only way of dealing with these problems is to realize the benefits.

Whoever in power must regard the national problems as their own. Our leadership seems to be without plans even for one generation. Banning use of polyethylene and keeping pollutant road transports out of urban areas are appreciable. Much more needs to be done. Action must begin from to-day to control noise pollution. The baton has to be passed from the scientists to the public, and then it must be translated into political and legislative action. The first two steps have already occurred, now it is time for the third.

We can never go back to our past to find vacant places around and the placid landscapes left by our forefathers. This can never happen again. If our children and grand children learn to have a healthy life, see the rivers and wetlands in harmony and full of biosphere reserve, see suitable traffic management everywhere, then, they should not be afraid of becoming environmental refugees because of global warming and sea level rise in future, get well managed cities and homesteads with cheaper and healthier provision of basic services and natural landscapes, they will surely remain contended in the houses they live in.

References:

1. Chowdhury, (Eds), 2009. Water and Environment. Forum of Environmental Journalists of Bangladesh, Dhaka, 20009.
2. মনিরুজ্জামান, এফ, এম, ২০০৯। বিপন্ন পরিবেশ ও বাংলাদেশ। আহমদ পাবলিশিং হাউস। ৬৬, প্যারীদাশ রোড, বাংলাবাজার, ঢাকা -১১০০।
3. Rashid, Rahman, A and Ahmed, S. 1994 Environmental and Ecological Aspects of Poverty and Implications for Sustainable Development in Bangladesh. Centre for Integrated Rural Development for Asia and the Pacific. Dhaka.
4. Revelle, Penelope and Charles Revelle, 1992. The Global Environment: Securing a Sustainable Future. Jones and Bartlett Publishers, Boston – London.
5. সিলভার শেরিল সাইমন ও রথ এস, ডেফ্রিস (অনুবাদঃ আফতাব হোসেন),১৯৯২. পরিবর্তনশীল পরিবেশ ও পৃথিবীর ভবিষ্যৎ। বাংলা একাডেমী, ঢাকা ।
6. Weiner, 1986. Planet Earth. Bantam Book. New York-London.

কৃষি উন্নয়নে বায়োটেকনোলজির ব্যবহার ও ঝুঁকি

নীলুফার ইয়াসমিন শেখ[১]

সারাংশ

বাংলাদেশে কৃষিবিজ্ঞানীগনের নিরলস প্রচেষ্ঠায় শস্যের উন্নত জাত উদ্ভাবণ ও প্রয়োজনীয় সেবাসমূহ নিশ্চিত করার ফলে মাত্র তিন দশকে দেশ খাদ্যে স্বয়ংসম্পূর্নতা অর্জন করে। কিন্তু বর্তমানে পৃথিবীর অন্যান্য দেশের মত এদেশেও প্রচলিত উদ্ভিদ প্রজনন পদ্ধতির কার্যকারীতা অনেকাংশে হ্রাস পেতে চলেছে । অন্যদিকে শস্যের উন্নত জাত উদ্ভাবণে বায়োটেকনোলজীর ব্যবহার ক্রমেই বৃদ্বি পাচ্ছে। তবে অন্যান্য অনেক দেশের তুলনায় বাংলাদেশে বায়োটেকনোলজির ব্যবহার অনেক বিলম্বে শুরু হয়েছে। বর্তমান সময়ের প্রেক্ষাপটে আমাদের উচিত এই অভিনব পদ্ধতি ব্যবহারের মাধ্যমে রোগ, কীট পতঙ্গ ও আগাছা প্রতিরোধী এবং অন্যান্য কাঙিখত বৈশিষ্ট্য সম্পন্ন উন্নত শস্যের জাত উদ্ভাবণ করা, যা শস্যের ফলন বৃদ্ধিতে অবদান রাখবে ।

অত্র প্রবন্ধে টিসু কালচার, ভ্রূণ কালচার, সোমাটিক এমব্রিয়োজেনেসিস, অ্যানথার কালচার, প্রোটোপ্লাস্ট কালচার, অগ্যান কালচার, জেনেটিক ইঞ্জিনিয়ারিং, একটি পপুলেশনের ডিএনএ এর মধ্যে পার্থক্য নির্ণয়, ডিএনএ পলিমর্ফিজম নির্নয়, জিন ট্যাগিং, জিনোম বিশেষণ ইত্যাদি বায়োটেকনোলজির বিভিন্ন দিক সমূহের উপর আলোকপাত করা হয়েছে । তাছাড়া, জেনেটিক্যালী মডিফায়েড (জি এম) শস্যের ক্রমবিকাশ ও বর্তমানে চাষাবাদের বিস্তৃতি সম্পর্কেও ধারনা দেওয়া হয়েছে। ১৯৯৪ ইং সালে প্রথম জিন শস্য যথা বিলম্বে পাকানো টমেটো উৎপাদনের পর হতে আগাছা প্রতিরোধী তুলা, সয়াবিন, ভূট্টা; কীট পতঙ্গ প্রতিরোধী বেগুন, গোলআলু, ভূট্টা,তুলা; ভাইরাস প্রতিরোধী পেঁপে, স্কোয়াশ, গোলআলু; ভাল গুণ বিশিষ্ট তৈল সমৃদ্ধ সয়াবীন, ক্যানোলা ইত্যাদি বর্তমানে চাষ হচ্ছে । বিশ্বজুড়ে ১৯৯৬ থেকে ২০০৫ সালের মধ্যে জিএম ফসলের আবাদী এলাকা বেড়েছে ৫০ গুণের বেশী । ২০০৬ সালে ২২টি দেশের প্রায় এক কোটে ৩০ লক্ষ কৃষক ২৫.২ কোটি একর জমিতে বায়োটেক পদ্ধতিতে উদ্ভাবিত শস্য চাষ করেছেন ।

প্রবন্ধের শেষাংশে বাংলাদেশে বায়োটেকনোলজির বর্তমান প্রয়াস সমূহ, বায়োটেকনোলজীর ভবিষ্যত ব্যবহার, এবং প্রয়োজনীয় সমর্থনাদির বিবরন দেওয়া হয়েছে। সর্বশেষে বায়োটেকনোলজিক্যাল পদ্ধতি ও জিএম ফসল ব্যবহারের কথিত ঝুঁকি সম্পর্কে আলোচনা করা হয়েছে। এ প্রসঙ্গেঁ ব্রি ধান- ২৯ এর মধ্যে ইরি, ফিলিপাইন কর্তৃক ভিটামিন এ উৎপাদনকারী জিন প্রবেশ করিয়ে "গোল্ডেন রাইস" সৃষ্টির কাহিনী এবং ঐ ধানের দ্বারা বাংলাদেশের অগণিত শিশুর অন্ধত্ব রোধের আশাবাদ ব্যক্ত করা হয়েছে।

ভূমিকা

কৃষি বিজ্ঞানীদের নিরলস প্রচেষ্টা ও আনুসঙ্গিক সেবাসমূহ নিশ্চিত করার ফলে ১৯৭১ ইং হতে ২০০০ইং সাল পর্যন্ত মাত্র ত্রিশ বছরে বাংলাদেশে কৃষি উৎপাদন প্রায় তিন গুণ বেড়েছে। গত শতাব্দীর ষাটের দশকে এসে কৃষি উন্নয়ন কর্মকান্ড বেগবান হতে থাকে। উদ্ভিদ প্রজননবিদগণ প্রচলিত কলা-কৌশল সমূহ ব্যবহার করে তৈরী করেন ফসলের নানা রকম উন্নত জাত। নির্দিষ্ট কিছু কাঙ্খিত বৈশিষ্ট্য সম্পন্ন দুটো জাত বা প্রজাতির সংকরীকরন (Hybridization) এর মাধ্যমে প্রচলিত পদ্ধতিতে নতুন শস্য জাত উদ্ভাবণ করা হয়। আমরা উদ্ভাবিত জাতটিতে নতুন বৈশিষ্ট্য বা গুণাবলী দেখতে পাই। বৈশিষ্ট্যটি আমাদের জন্য উপকারী হলে বংশ পরম্পরায় যাতে বৈশিষ্ট্যটি নতুন জাতটিতে স্থায়ী হয় তা নিশ্চিত করে কৃষকের ব্যবহারের জন্য তা অবমুক্ত (Release) করা হয়।

এই প্রক্রিয়া এক উদ্ভিদের ফুলের পরাগরেণু অন্যগাছের ফুলের স্ত্রী-অঙ্গে স্থানান্তরের মাধ্যমে সম্পন্ন হয়। এই পর-পরাগায়ন (Cross Fertilization) একই বা খুব নিকটবর্তী

১ উর্দ্ধতন বৈজ্ঞানিক কর্মকর্তা, বাংলাদেশ ধান গবেষণা ইনাস্টটিউট, জয়দেবপুর, গাজীপুর

সম্পর্কযুক্ত প্রজাতির মধ্যে সীমিত থাকে। এক্ষেত্রে কাঙ্খিত ফলাফল অর্জনে দীর্ঘ সময় লাগে এবং সব সময় আশানুরূপ বৈশিষ্ট্য পাওয়াও যায়না। এছাড়া প্রচলিত ফসল উন্নয়ন পদ্ধতির কিছু সমস্যা রয়ে যায়, যেগুলোর সমাধান এতদিন সম্ভব হয়নি।

শস্যের জাত উন্নয়নে অন্যান্য অনেক দেশের তুলনায় এদেশে বায়োটেনোলজির ব্যবহার অনেক বিলম্বে শুরু হয়েছে। অথচ আধুনিক বায়োটেকনোলজির জ্ঞান ব্যবহার করে অনেক উন্নত ও উন্নতিশীল দেশ কৃষির প্রভূত উন্নয়ন ঘটিয়ে চলছে। বস্তুত: বায়োটেকনোলজি আধুনিক বিজ্ঞানের একটি ফলিত শাখা। বর্তমান সময়ের প্রেক্ষাপটে আমাদের উচিত বায়োটেকনোলজি ব্যবহার করে শস্যের উৎপাদন বাড়ানো; কীট পতঙ্গ, আগাছা প্রতিরোধী ও অন্যান্য কাঙ্খিত বৈশিষ্ট্য সম্পন্ন শস্যের জাত সৃষ্টি করা, যা শস্যের ফলন বৃদ্ধিতে অবদান রাখবে।

বায়োটেকনোলজির গুরুত্ব

গ্রেগর জোহান মেন্ডেল মটরশুটি নিয়ে তাঁর বিখ্যাত গবেষণার মাধ্যমে পৃথিবীর মানুষের কাছে বংশগতির রহস্য উন্মোচন করেন ১৮৬৫ সালে। বিংশ শতাব্দীর শুরুতে জানা সম্ভব হয়, পিতামাতা থেকে সন্তানে কিভাবে বৈশিষ্ট্য সঞ্চারিত হয় । ১৯৫৩ সালে ওয়াট্সন ও ক্রিক নামক দুজন বিজ্ঞানী আবিষ্কার করেন ডিএনএ (DNA) অণুর গঠন রহস্য। বায়োটেকনোলজীর গবেষণায় একটি জীব থেকে একটি নির্দিষ্ট জিন বহনকারী ডিএনএ খন্ড পৃথক করে ভিন্ন একটি জীবে স্থানান্তরের কৌশলকে জেনেটিক ইঞ্জিনিয়ারিং(Genetic Engineering) বলে । জেনেটিক ইঞ্জিনিয়ারিং পদ্ধতিতে এই জিন বিনিময় ঘটানো হয় DNA অণু পর্যায়ে ল্যাবরেটরীতে সংরক্ষিত কোষে। সেখান হতে কালচার (Culture) করে তা থেকে নতুন গাছ উদ্ভাবণ হয়, যা জিএমও (Genetically Modified Organism/GMO) নামে অভিহিত। যে কৌশলগুলোর মাধ্যমে জিন স্থানান্তর করা হয় তাদের একত্রে রিকম্বিন্যান্ট ডিএনএ (Recombinant DNA) কৌশল বলে। প্রচলিত পদ্ধতিতে সংকরীকরনের মাধ্যমে যে নতুন জাতের উদ্ভব হয় সেটাও জিএমও; দু'ধরনের জিএমওর মধ্যে মূলতঃ কোন তফাৎ নেই। Genetic Engineering প্রচলিত উদ্ভিদ প্রজনন (Conventional Plant Breeding) এরই একটি নতুন শাখা। তবে বায়োটেকনোলজির জিএমও প্রযুক্তি অধিকতর কম সময়ে উৎকৃষ্ট জাত তৈরী করার সুযোগ করে দেয়।

এভাবে *Agrobacterium* এর মাধ্যমে ফলপ্রদ ট্রান্সফরমেশন পদ্ধতি এবং রূপান্তরিত টিস্যুর রিজেনারেশন দক্ষতার উন্নয়নের সঙ্গে সঙ্গে প্ল্যান্ট জেনেটিক ইঞ্জিনিয়ারিং এবং প্ল্যান্ট টিস্যু কালচার কৃষি উন্নয়নে এক বিপ্লবের সূচনা করেছে । প্ল্যান্ট জেনেটিক ইঞ্জিনিয়ারিং পদ্ধতি কাঙ্খিত জিনকে নির্বাচিত উদ্ভিদের দেহে স্থানান্তরের পথ তৈরী করেছে। উদ্ভিদ, প্রাণী বা অনুজীব থেকে পৃথকীকৃত জিনকে গুরুত্বপূর্ন ফসলী উদ্ভিদে স্থায়ীভাবে অনুপ্রবেশ ঘটিয়ে সেখানে উক্ত জিনের প্রকাশ ঘটানো হচ্ছে। মলিকুলার বায়োলজির সুক্ষ্ম কৌশলের মাধ্যমে বিভিন্ন পরজীবী রেসিস্ট্যান্ট জিনের ম্যাপ, ক্লোন এবং জিন সুবিন্যাস করে বায়োটেকনোলজী-বিজ্ঞানীগণ সবুজ বিপ্লবকে উন্নত স্তরে এগিয়ে নেয়াকে এক চ্যালেঞ্জ হিসেবে গ্রহণ করেছেন। এছাড়াও Restriction Fragment Length Polymorphism (RFLP) এর সাহায্যে একটি পপুলেশনের ডিএনএ এর মধ্যে পার্থক্য নির্ণয়; Random Amplified Polymorphic DNA (RAPD) কৌশলের মাধ্যমে PCR এর উপর ভিত্তি করে ডিএনএ পলিমর্ফিজম নির্ণয়; Quantitative Trait Loci (QTL) বিশ্লেষণ; জিন ট্যাগিং; DNA ফিংগার প্রিন্টিং এর মাধ্যমে ইনডিভিজুয়াল স্পেসিফিক এবং জেনেটিক ভ্যারিয়েশন, পপুলেশন জেনেটিক্স এবং জেনোম বিশ্লেষণ ইত্যাদি বায়োটেকনোলজির বিভিন্ন দিক সমূহে গবেষণার পরিধি ক্রমশ: বিস্তৃত করেছে। এভাবে গত ত্রিশ বছর ধরে বায়োটেকনোলজির মাধ্যমে কৃষিতে অভূতপূর্ব সাফল্য অর্জিত হয়েছে।

বায়োটেকনোলজির ব্যবহার

উন্নত বিশ্বে প্রমাণিত হয়েছে যে, বায়োটেকনোলজির মাধ্যমে শস্যের উন্নয়ন ও জিএম শস্যের ব্যবহার তাৎপর্যপূর্ণ উপকার বয়ে এনেছে। যেমনঃ জিএম ফসল কৃষকের জন্য ফসলের ফলন বৃদ্ধি করে, খামারের ব্যয় কমায়, স্বাস্থ্য ও পরিবেশের উন্নয়ন করে। এছাড়াও কিছু জিএম শস্য অত্যন্ত উপকারী এবং অধিক গ্রহণযোগ্য। যেমনঃ আয়রন ও ভিটামিন সমৃদ্ধ ধান, উচ্চ স্টার্চ সমৃদ্ধ আলু, তুলনামূলকভাবে শুষ্ক জমিতে জন্মানোর ক্ষমতাধর ভূট্টার জাত, সয়াবিন ও ক্যানোলা থেকে স্বাস্থ্যসম্মত তৈল ইত্যাদি। ১৯৯৪ সালে প্রথম জিএম শস্য, যথা: বিলম্বে পাকানো (Delayed Ripening) টমেটো (Flavr Savr ^{TM}) উৎপাদিত ও ব্যবহৃত হয়েছিল (ISAAA, 2005)। Antisense RNA কৌশলের মাধ্যমে ইথিলিন উৎপাদন বন্ধ করে এই বিলম্বে পাকা টমেটোর জাত তৈরী করা হয়েছে। বানিজ্যিকভাবে জিএম ফসল আবাদ হচ্ছে অনেক। যেমন - আগাছা প্রতিরোধী তুলা, সয়াবীন, ভুট্টা; কীটপতঙ্গ প্রতিরোধী বেগুন, গোলআলু, ভুট্টা, তুলা; ভাইরাস প্রতিরোধী পেঁপে, স্কোয়াশ, গোলআলু; বিলম্বিত ফল পাকা বৈশিষ্ট্যের টমেটো, ভাল গুণ বিশিষ্ট তৈল সমৃদ্ধ সয়াবীন, ক্যানোলা ইত্যাদি (ভূঁইয়া ২০০৮)। সারা বিশ্বে জিএম শস্যের আবাদকৃত এলাকা ১৯৯৬ সালে ১.৭ মিলিয়ন হেক্টর ছিল, তা বৃদ্ধি পেয়ে ২০০২ সালে ৫৮ মিলিয়ন এবং ২০০৪ সালে তা ৮১ মিলিয়ন হেক্টরে উঠেছে। বিশ্ব জুড়ে ১৯৯৬ থেকে ২০০৫ সালের মধ্যে জিএম ফসলের আবাদী এলাকা বেড়েছে ৫০ গুণের বেশী। ২০০৬ সালে ২২টি দেশের প্রায় ১ কোটি ৩০ লক্ষ কৃষক ২৫.২ কোটি একর জমিতে বায়োটেক শস্য চাষ করেছেন (ISAAA, 2005)।

উদ্ভিদের পুং-বন্ধ্যাত্বতা

হাইব্রিড সৃষ্টিতেও জিন প্রযুক্তি ব্যবহৃত হয়েছে যেমন- পুংবন্ধ্যাত্ব (Male sterility) সৃষ্টি এবং উর্বরতা প্রত্যার্পন (Fertility Restoration) করা হয়েছে বেশ কিছু উদ্ভিদ প্রজাতিতে (ইসলাম এবং রহমান, ১৯৯৯)। বিভিন্ন Anther specific promoter (তামাকের TA29 জিন থেকে নেয়া) এবং ব্যাক্টেরিয়ার রাইবোনিউক্লিয়েজ জিন দ্বারা সরিষা উদ্ভিদে স্বাভাবিক রেণু (pollen) উৎপাদন রোহিত করে পুং-বন্ধ্যাত্বে (Male sterile) রূপান্তরিত করা হয়। তামাক, লেটুস, তুলা, টমেটো, আলু ইত্যাদি উদ্ভিদেও এই জিন স্থানান্তর করা হয়েছে (ইসলাম এবং রহমান, ১৯৯৯)

আগাছা-নাশক প্রতিরোধী জিএম ফসল

আগাছা ফসলের একটি প্রধান শত্রু। আধুনিক বিশ্বে ক্রমাগত রাসায়নিক আগাছা নাশকের (হার্বিসাইড) ব্যবহার চলছে যা কিনা পরিবেশের উপর ও মানব স্বাস্থ্যের জন্য ক্ষতিকর। এক্ষেত্রে বায়োটেকনোলজির মাধ্যমে আগাছা-নাশক প্রতিরোধী ফসল তৈরী করা সম্ভব। হার্বিসাইড সাধারনতঃ সালোক সংশ্লেষণ এবং এমিনো এসিড সংশ্লেষণে প্রতিবন্ধকতার সৃষ্টি করে। কোন কোন ব্যাকটেরিয়া এমন এনজাইম তৈরী করে যা আগাছানাশককে নির্বিষ করে দিতে সক্ষম। সেই এনজাইম উৎপাদনকারী জিনগুলোকে আলাদা করে নিয়ে ক্লোনিং করে জিনের সংখ্যা বাড়িয়ে নিয়ে ফসলের মধ্যে ঢুকিয়ে দিয়ে এটা সম্ভব হয়। বিভিন্ন ধরনের ডি-টক্সিফাইং এনজাইম উদ্ভিদ এবং অনুজীবে ইতোমধ্যে সনাক্ত করা হয়েছে। যেমন: ভূট্টাতে পাওয়া গেছে গুটাথিওন-s-ট্রান্সপারেজ (GST) জিন, যা এট্রাজিন নামক হার্বিসাইডের বিরুদ্ধে কাজ করে। *Klebsiella pneumonial* নামক ব্যাক্টেরিয়াতে পাওয়া গেছে *bxn* নামক জিন। এটা নাইট্রিলেজ নামক এনজাইম তৈরী করে, যা সহজেই ব্রোমাক্সিলিন নামক হার্বিসাইডকে ডি-টক্সিফাই করে। এছাড়া সরিষা, তামাক এবং আলুতে, *Streptomyces hygroscopicus* থেকে প্রাপ্ত bar gene দ্বারা এবং টমেটো, *Klebsiella* থেকে প্রাপ্ত *bxn* জিন দ্বারা রূপান্তর করে হার্বিসাইড প্রতিরোধক উদ্ভিদ উদ্ভাবণ করা হয়েছে (ভূঁইয়া, ২০০৮) । যুক্তরাষ্ট্রে আগাছা নাশক সহনশীল সয়াবিন প্রবর্তনের ফলে মোট উৎপাদন ৩৫% বৃদ্ধি পেয়েছে। এমনকি আর্জেন্টিনাতে ৯৮% আগাছা নাশক সহনশীল জাতের সয়াবিন চাষ করা হয় (ISAAA, 2005)।

কীট প্রতিরোধী জিএম ফসল

কীট প্রতিরোধী ফসলের জাত সৃষ্টি বায়োটেকনোলজি বিজ্ঞানীদের ফসল উন্নয়ন কর্মকান্ডের অন্যতম লক্ষ্য। এক্ষেত্রে বহু অণুজীবে এবং কিছু উদ্ভিদে বিষাক্ত প্রোটিন উৎপাদনকারী জিন রয়েছে যেগুলো ফসলের ক্ষতিকারক কীটপতঙ্গের উপর বিষক্রিয়া করে থাকে। এসব জিন কেটে নিয়ে সংযোজন করে তৈরী হয় কীট প্রতিরোধী জিএম ফসল। এভাবে তৈরী হয়েছে *Bacillus thuringiensis* নামক ব্যাক্টেরিয়া হতে নেওয়া Bt জিন সম্বলিত ট্রান্সজেনিক ফসল তামাক, বেগুন, তুলা, গোলআলু, টমেটো, আপেল ইত্যাদি (ভূঁইয়া, ২০০৮)। এই Bt জিন ক্রিস্টাল প্রোটিন (Crystal protein), সংক্ষেপে cry প্রোটিন সৃষ্টি করে যা কীটবিনাশী। বিটি -১১ একটি জিএম ভুট্টা, যা এক ধরনের প্রোটিন ধারনের মাধ্যমে কর্ণ বোরার (ছিদ্রকারী) কীট প্রতিরোধী। ফিলিপাইনে ২০০৩ সালে Bt ভূট্টার উৎপাদন প্রচলিত ভূট্টার জাতের চেয়ে ৩০% ভাগ বেশী হয়েছে এবং কীটনাশক সংক্রান্ত ব্যয় ৫৬% ভাগ কম হয়েছে। আগাছা প্রতিরোধী জি এম সয়াবিন, সরিষা, তুলা ও ভুট্টার জাত এবং কীট প্রতিরোধী জি এম তুলা ব্যবহারের ফলে ২০০০ সালে সমগ্র বিশ্বে আনুমানিক ২২.৩ মিলিয়ন কেজি কীটনাশক ব্যবহার কমিয়ে আনা সম্ভব হয়েছে। কীট প্রতিরোধী Bt জাত সমূহের সঠিক ব্যবহার সমগ্র বিশ্বে কীটনাশকের ব্যবহার ১৪% কমিয়ে আনবে বলে অনুমান করা হচ্ছে । আর্জেন্টিনা, যুক্তরাষ্ট্র, চীন, ভারত, ইন্দোনেশিয়া, কানাডা, প্রভৃতি দেশগুলোতে ১৯৯৬ থেকে ২০০৪ সালের মধ্যে বানিজ্যিকভাবে Bt তুলা ও Bt ভূট্টা চাষ করেছে (ISAAA, 2005)।

ভাইরাস ও ব্যাক্টেরিয়া প্রতিরোধী ট্রান্সজেনিক উদ্ভিদ

ভাইরাস ও ব্যাকটেরিয়া জনিত রোগ প্রতিরোধী ফসলও উদ্ভাবিত হয়েছে। যেমন - TMV(Tomato mosaic virus) থেকে পৃথককৃত কোট প্রোটিন (cp) জিন স্থানান্তর করে তামাক, টমেটো, আলু, ধান ইত্যাদি ফসলি উদ্ভিদ রূপান্তর করা হয়েছে। ইতোমধ্যে পেঁপে ও স্কোয়াশের ভাইরাস প্রতিরোধী জিএম জাত আবাদ শুরু হয়েছে আমেরিকাসহ দু একটি দেশে । অবমুক্তির আশায় রয়েছে শশা, বাঙ্গি, তরমুজ ইত্যাদি জিএম ফসল (ভূঁইয়া, ২০০৮)। যুক্তরাষ্ট্রের হাওয়াইয়ে তৈরী জিএম পেঁপে একটি ভাইরাসের জিন ধারন করে, যা পেঁপে রিং স্পট ভাইরাসের (PRSV) জন্য একটি কোট প্রোটিন অন্তর্ভূক্ত করে। এই প্রোটিন পেঁপে গাছে PRSV এর বিরুদ্ধে প্রতিরোধ গড়ে তোলে (ISAAA, 2005)। আবার ম্যাপ ভিত্তিক ক্লোনিং এবং জিন ট্যাগিং কৌশলসমূহ অবলম্বন করে রোগ প্রতিরোধী জিন (Resistance gene) ফসলে সংযোজন করে রোগ প্রতিরোধ-ক্ষমতা সৃষ্টির চেষ্টা শুরু হয়েছে। ধানের Xa21 জিন সংযোজন ধানের পাতা ঝলসানো (Bacterial Leaf Blight) রোগ সৃষ্টিকারী ব্যাক্টেরিয়ার (*Xanthomonas oryzae*) বিরুদ্ধে প্রতিরোধ ক্ষমতা প্রদর্শন করতে সক্ষম হয়েছে। (ভূঁইয়া, ২০০৮)

অজীবীয় পীড়ন সহনশীল জি এম ফসল

নানা অজীবীয় পীড়ন (Abiotic stress) যেমনঃ লবনাক্ততা, খরা, বন্যা, ভারী মেটাল (আর্সেনিক) ও নাইট্রোজেন ইত্যাদি সহনশীল নানা প্রকার ফসলের সৃষ্টি সম্ভব হয়েছে বায়োটেকনোলজির মাধ্যমে । যেমনঃ আমাদের দেশে বন্যার প্রকোপে আমন ধানের উৎপাদন ব্যাপকভাবে ক্ষতিগ্রস্থ হয় । এ সমস্যা সমাধানে আমনের জনপ্রিয় জাত বি আর-১১ ও স্বর্ণায় জলমগ্ন সহিষ্ণু জিন সাব-ওয়ান ঢোকানো সম্ভব হয়েছে (প্রথম আলো, ১৫.১১.০৮)। আলবার্টা বিশ্ববিদ্যালয়ের একদল বিজ্ঞানী ধানে এমন কিছু জিন সনাক্ত করেছেন, যার মাধ্যমে উঁচু জমিতে এবং খরা প্রবণ-অঞ্চলে সেচ ছাড়াই ধানের উৎপাদন দ্বিগুন করা সম্ভব হবে। এই জিনগুলো ধান গাছের মূলকে মাটির আরও গভীরে বাড়তে সাহায্য করে। এর ফলে ধান গাছ মাটি থেকে প্রয়োজনীয় পানি গ্রহণ করতে পারে (প্রথম আলো, ২৩.১১.০৮)। এরুপ ফসল উদ্ভাবণের মাধ্যমে ফসল উৎপাদনে উল্লে-খযোগ্য পরিবর্তন আনা হচ্ছে।

ফুলের বর্ণে রূপান্তর ও সংরক্ষণ-কাল বৃদ্ধি

অষ্ট্রেলিয়া এবং জাপানে ফুলের বর্ণ ও গন্ধ পরিবর্তন সহ ফুলকে অনেক বেশী দিন সংরক্ষণ করার জন্য ব্যবহৃত হচ্ছে বায়োটেকনোলজি। বিজ্ঞানীরা ফুলের বর্ণে রূপান্তর ঘটাতে যা করছেন তা হল ঃ (১) অ্যান্থোসায়ানিন জীবসংশ্লষন পথক্রমের একটি জিনের প্রকাশকে অবমান করা। (২) কোন নির্দিষ্ট জীনের অতিপ্রকাশ ঘটিয়ে একটি নির্দিষ্ট রঞ্জক উৎপাদন করা। (৩) হেটেরোলোগাস জিন (Heterologus Gene) এর প্রকাশ ঘটিয়ে কোন একটি অভিনব (Novel) রঞ্জক উৎপাদন করা। (ভূঁইয়া, ২০০৮) আবার বিজ্ঞানীরা ফুলের সংরক্ষণ-কাল বাড়ানোর জন্য সিনথিজ এবং অক্সিডেজ নামক দুটো এনজাইমের সংশ্লেষণ বন্ধ করার জন্য একটি জিন ফুল গাছে প্রবেশ করিয়েছেন। ফলে ইথিলিন উৎপাদন হতে পারে না এবং ফুল অনেকদিন সংরক্ষণ করা সম্ভব হয়। এছাড়াও বিলম্বে পরিপক্ব প্রযুক্তি ব্যবহৃত হচ্ছে টমেটো, তরমুজ, পেঁপে প্রভৃতি ফসলে। এতে কৃষক, ভোক্তা সবাই উপকৃত হচ্ছে।

টিস্যু কালচার প্রযুক্তি

প্ল্যান্ট টিস্যু কালচার বলতে ফর্মুলেটেড পুষ্টির মাধ্যমে উদ্ভিদ কোষ, টিস্যু অথবা অর্গানকে ইনভিট্রো (*in vitro*) অবস্থায় কালচার করাকে বুঝায়। এটি একটি উদ্ভিদের একক কোষ থেকে পুনরায় সেই উদ্ভিদ তৈরীর পদ্ধতি। উদ্ভিদ টিস্যু কালচার প্রযুক্তি ৩০ বছরের বেশী সময় ধরে চলে আসছে। উন্নয়নশীল দেশে রোগমুক্ত, উচ্চ গুণসম্পন্ন উদ্ভিদ উপকরন ও অনেক সমরূপ উদ্ভিদের দ্রুত উৎপাদন (Micropropagation) এবং প্রোটোপ্লাস্ট কালচার (Protoplast Culture); সেল বা অর্গান কালচার (Cell and Organ Culture); সোমাটিক এমব্রিয়োজেনেসিস (Somatic embryogenesis); ভ্রূণ কালচার (Embryo Culture); পরাগধানী কালচার (Anther Culture) ইত্যাদি টিস্যু কালচারের গুরুত্বপূর্ণ প্রযুক্তিসমূহ ব্যবহৃত হচ্ছে।

প্রোটোপ্লাস্ট কালচার (Protoplast Culture)

এই প্রক্রিয়ায় প্রথমে উদ্ভিদ কোষ থেকে এনজাইম বিক্রিয়ার মাধ্যমে প্রোটোপ্লাস্ট সংগ্রহ করা হয় এবং তাদের মধ্যে ফিউশনকৃত প্রোটোপ্লাস্ট পরবর্তীতে টিস্যু কালচার পদ্ধতিতে রিজেনারেশন (Regeneration) করে নতুন বৈশিষ্ট্য সম্পন্ন উদ্ভিদ উদ্ভাবণ করা হয়। প্রোটোপ্লাস্ট সংযোগকারী পদার্থ হিসেবে Polyethylene Glycol (PEG) ব্যবহৃত হয়। উদাহরন স্বরূপ, Nicotiana, Citrus, Brassica, Solanum প্রভৃতি উদ্ভিদে প্রোটোপ্লাস্ট সংযোগ করে পূর্নাঙ্গ উদ্ভিদ উৎপন্ন করা হয়েছে। এই প্রক্রিয়ায় কাঙ্খিত বৈশিষ্ট্যের জিন স্থানান্তর করে বংশগতিতে উন্নয়ন সাধন সম্ভব। অঙ্গজ বংশ বিস্তারকারী উদ্ভিদে জিনগত ভিন্নতা আনাও সম্ভব ।

সেল বা অর্গান কালচার (Cell and Organ Culture)

বিভিন্ন উদ্ভিদ প্রজাতিতে অত্যন্ত অল্প পরিসরে অসংখ্য উদ্ভিদ উৎপাদন করা যায় এই পদ্ধতিতে । উদ্ভিদ দেহের সজীব অংশ থেকে প্রথমে ক্যালাস (Callus) উৎপন্ন করা হয়। পরে পুনরায় পৃথক মিডিয়ামে কালচার করা হয়। ফলে তা থেকে অঙ্গজ ভ্রূণের (Vegetative Embroid) উৎপত্তি হয় যা থেকে মূল, কান্ড সৃষ্টির মাধ্যমে পূর্নাঙ্গ উদ্ভিদ পাওয়া যায়।

সোমাটিক এমব্রিয়োজেনেসিস (Somatic Embryogenesis)

এ প্রক্রিয়ায় উদ্ভিদ কোষ বা কলা থেকে স্বাভাবিক ভ্রূণের (Zygotic Embryo) ন্যায় অসংখ্য ক্ষুদ্র ভ্রূনের বিকাশ ঘটে। ফলে প্রচুর সংখ্যক অনুচারা পাওয়া যায়। এক্ষেত্রে ভ্যারিয়েশন (Variation) যুক্ত উদ্ভিদ সমুহ থেকে কাঙ্খিত চরিত্রযুক্ত উদ্ভিদ নির্বাচন করা যায়। উদ্ভুত ভ্রূণগুলো (embryoid) মিউটেশন ঘটিত পরীক্ষা নিরীক্ষাতে বিশেষ গুরুত্ব পায় । এগুলো সাধারনত রোগজীবাণুমুক্ত হয়।

ভ্রূন কালচার (Embryo culture)

গবেষণাগারে ডিম্বক (Ovule) থেকে ভ্রূণ (Embryo) বিচ্ছিন্ন করে কালচার করা হয়। আন্ত প্রজাতি সংকরায়নের (Interspecific Hybridization) ফলে যখন উদ্ভূত ভ্রূণ স্বাভাবিক পূর্ণতা পায়না তখন এই বিশেষ প্রক্রিয়ায় ভ্রূন উদ্ধার (embryo rescue) করে কালচার মিডিয়ামে (culture medium) ভ্রূণের বৃদ্ধি নিশ্চিত করা যায়।

পরাগধানী কালচার (Anther culture)

এক্ষেত্রে বিশেষ কৌশলের মাধ্যমে পরাগধানীকে বিশেষ বিশেষ দশাতে (Stage) কৃত্রিম নিউট্রিয়েন্ট মিডিয়ামে (nutrient medium) ও জীবানুমুক্ত পরিবেশে কালচার করা হয়। এ প্রক্রিয়াতে ক্যালাস (Callus) বা ভ্রূণ বিকশিত হয়ে হ্যাপ্লয়েড (Haploid) উদ্ভিদ সৃষ্টি হয়। বংশগতির গবেষণাতে হ্যাপ্লয়েড উদ্ভিদের বিশেষ গুরুত্ব রয়েছে। কেননা হ্যাপ্লয়েড উদ্ভিদগুলোতে এক সেট ক্রোমোজোম থাকে এবং প্রচ্ছন্ন (Recessive) জিন ঘটিত চারিত্রিক বৈশিষ্ট্যের বহিঃপ্রকাশ ঘটতে দেখা যায় । প্রকৃতিতে প্রতিনিয়ত যে মিউটেশন (Mutation) ঘটে চলেছে তার অধিকাংশই প্রচ্ছন্ন ধরনের, ফলে ডিপ্লয়েড (Diploid) কোষে এর কোন বহিঃপ্রকাশ ঘটতে দেখা যায় না। বিশেষ করে হিটারোজাইগাস (Heterozygous) অবস্থায় মিউটেশনবিহীন প্রকট (Dominant) জিনের উপস্থিতি মিউটেশন ঘটিত অপর প্রচ্ছন্ন জিনের বহিঃপ্রকাশে বাধা সৃষ্টি করে। কিন্তু হ্যাপ্লয়েড উদ্ভিদে মিউটেশন ঘটিত পরিবর্তনের প্রকাশ সহজেই দেখা যায় । অনেক ক্ষেত্রে কাঙ্খিত মিউট্যান্ট লাইন (Mutant line) পাওয়া যেতে পারে। এই কালচার পদ্ধতিতে অতি অল্প সময়ে হোমোজাইগাস ডিপ্লয়েড (Homozygous diploid) লাইন পাওয়া যায় যা ব্রিডিং (Breeding) পদ্ধতিতে সময় সাপেক্ষ। এছাড়াও Anther culture থেকে ক্যালাস কালচার করে বিভিন্ন মাত্রার প্লয়েডীর (Ploidy) উদ্ভব ঘটতে পারে এবং জিনগত ভিন্নতার (Genetic Variation) সৃষ্টি করতে পারে ।

মাইক্রোপ্রোপাগেশন (Micropropagation)

মাইক্রোপ্রোপাগেশনের (Micropropagation) মাধ্যমে অল্প সময়ে একটি উদ্ভিদের হাজার অনুলিপি উৎপাদন করা যায়। আমাদের দেশে এই প্রক্রিয়ায় কলা, বেগুন, আলু, টমেটো, অর্কিড প্রভৃতির টিস্যু কালচার হচ্ছে এবং তা দিয়ে শস্য ও ফুল উৎপাদন হচ্ছে।

মার্কারের সাহায্যে নির্বাচন প্রযুক্তি

একটি উদ্ভিদের ডিএনএ (DNA) এর সংগে অন্য উদ্ভিদের ডিএনএ এর পার্থক্য রয়েছে। একটি নির্দিষ্ট বৈশিষ্ট্য (যেমনঃ ফুলের রং) প্রায়শঃই একটি জিন (Gene) দ্বারা নিয়ন্ত্রিত হয়, তবে অনেক জটিল বৈশিষ্ট্য যথাঃ শস্যের ফলন বা স্টার্চের পরিমান ইত্যাদি বৈশিষ্ট্য একাধিক বা অনেক জিন দ্বারা প্রভাবিত হতে পারে। উদ্ভিদ প্রজননবিদগণ তাদের দেখা বা পরিমাপযোগ্য ফিনোটাইপ (Phenotype) এর উপর ভিত্তি করে কাংখিত গাছ নির্বাচন (Selection) করে থাকেন। কিন্তু আধুনিক কালের বিজ্ঞানীরা নির্দিষ্ট জিনকে চিহ্নিত করতে সহজ পন্থা হিসাবে জেনেটিক মার্কার (Genetic Marker) ব্যবহার করছেন। মার্কার হচ্ছে নিউক্লিক এসিডের সিকোয়েন্স (Nucleic Acid Sequence) যা ডিএনএ খন্ডাংশ তৈরী করে। মার্কারগুলো কাঙ্খিত জিনের ডিএনএ সিকোয়েন্স (DNA sequence) এর কাছে অবস্থান করে এবং পরবর্তী বংশধরে প্রেরিত হয়। মার্কার একটি জিনের অবস্থান নির্দেশ করে এবং অন্যান্য জানা জিন থেকে তাদের দুরত্ব দেখায়।

কৌলিক পার্থক্য (Genetic Distance) নিরূপণ এবং জার্মপ্লাজমের বৈশিষ্টায়ন; জিনোটাইপ (Genotype) চিহ্নিতকরন এবং ফিঙ্গার প্রিন্টিং (Fingerprinting); মনোজেনিক এবং পরিমানগত বৈশিষ্ট্যের লোসাই (Quantitative

Trait Loci) চিহ্নিতকরন; পপুলেশন, ইনব্রিড এবং প্রজনন উপকরণের কৌলিক দূরত্ব (Genetic Distance) নির্ণয় এবং উপকারী জিনের সিকোয়েন্স (Gene Sequence) চিহ্নিতকরণ ইত্যাদিতে মার্কারের প্রধান ব্যবহার।

বর্তমানে কৃষি শস্যে জিনোমিক্স তথা নির্দিষ্ট শস্যের জিনোমের সকল সিকোয়েন্স আবিষ্কার ও নির্দেশন; প্রোটিওমিক্স তথা কোষে প্রোটিনের গঠন ও কাজ, পারস্পরিক ক্রিয়া ও জীব পদ্ধতিতে এর অবদান ইত্যাদি নিয়ে গবেষণা চলছে। আন্তর্জাতিক ধান জিনোম সিকোয়েন্সিং প্রকল্প ২০০২ সালে ধানের জিনোম এর সম্পূর্ণ সিকোয়েন্সের নকশা (ধানের ১২ টি ক্রোমোজোম) প্রকাশ করেছে (ISAAA, 2005)।

বায়োটেকনোলজির ভবিষ্যত ব্যবহার

ফসলের গুণগত ও পুষ্টিমান বৃদ্ধিতেও বায়োটেকনোলজি ব্যবহৃত হচ্ছে। যেমনঃ ২০০২ সালে দেশের সবচেয়ে বেশী ফলনশীল ব্রি ধান-২৯ এর ক্রোমোজমের মধ্যে ভিটামিন A উৎপাদনকারী জিন প্রতিস্থাপন করে তৈরী হয়েছে ভিটামিন A সমৃদ্ধ ধান "গোল্ডেন রাইস"। এ ধানটি অবমুক্ত করতে ৫-৬ বছর সময় লাগতে পারে (প্র. আ. ১৫.১১.০৮)। আগামী দিনের পরিবেশের উপযোগী ফসল তৈরীতে এবং নানা সমস্যা নিরসনে রূপান্তরিত উন্নতমানের ফসল উৎপাদনে বায়োটেকনোলজীর প্রয়োগ দিন দিন বৃদ্ধি পাচেছ। ফসলের উৎপাদনশীলতা বৃদ্ধির উদ্দেশ্যে সালোক সংশ্লেষনের দক্ষতা বৃদ্ধি করার চিন্তা ভাবনা করছেন জাপানি বিজ্ঞানী Ku এবং তাঁর সঙ্গীরা। তাঁরা জিন প্রযুক্তি প্রয়োগ করে ধানের ফলন বাড়াতে পেরেছেন। সালোকসংশ্লেষনের জন্য উদ্ভিদের C_4 পথক্রম C_3 পথক্রম অপেক্ষা বেশী দক্ষতার সাথে বায়ুর CO_2 কে কাজে লাগাতে পারে। বিজ্ঞানীরা C_4 পথক্রমের জন্য দায়ী আরো দুটো জিনকে ধানে সংযোজনের চেষ্টা করছেন। তাতে ফলন আরও বেড়ে যাবে। ফসলে সার প্রয়োগের বিকল্প স্বরূপ নাইট্রোজেন সংবন্ধনক্ষম জিন শিমজাতীয় নয় এমন ফসলে সংযোজনের জন্য চেষ্টাও চলছে। বাদাম সহ আরও কিছু এলার্জি সৃষ্টিকারী ফসলের এলার্জেনকে অপসারনের জন্য জিন প্রযুক্তি ব্যবহার করা হচেছ। এভাবে তৈরী করা হয়েছে রূপান্তরিত সয়াবিনও (ভূঁইয়া, ২০০৮)।

বাংলাদেশে বায়োটেকনোলজি

বিজ্ঞানীরা বাংলাদেশে কোন জিএম ফসল উদ্ভাবণ করতে সক্ষম হননি এবং আবাদও এখনো শুরু হয়নি। তবে জিএম ফসলে উৎপন্ন দ্রব্য আমরা জেনে এবং না জেনে খেতে শুরু করেছি। যেমনঃ বিদেশ থেকে আমদানীকৃত সয়াবিন তৈল, টমেটো কেচাপ (Tomato Ketch up) ইত্যাদি। বাংলাদেশে বর্তমানে যেসব সরকারী প্রতিষ্ঠানে বায়োটেকনোলজির পদ্ধতি ব্যবহার করে শস্যের জাত উদ্ভাবন করার চেষ্টা হচেছ, সেগুলি হচেছ, (১) বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট, (২) বাংলাদেশ ধান গবেষণা ইনস্টিটিউট, (৩) বাংলাদেশ পাট গবেষণা ইনস্টিটিউট, (৪) বাংলাদেশ পরমাণু কৃষি গবেষণা ইনস্টিটিউট, (৫) বাংলাদেশ ইক্ষু গবেষণা ইনস্টিটিউট, (৬) বাংলাদেশ কৃষি বিশ্ববিদ্যালয়, (৭) ঢাকা বিশ্ববিদ্যালয়, (৮) ন্যাশনাল ইনস্টিটিউট অফ বায়োটেকনোলজি (৯) বঙ্গবন্ধু শেখ মুজিবুর রহমান কৃষি বিশ্ববিদ্যালয়, (১০) রাজশাহী বিশ্ববিদ্যালয়, (১১) শেরে বাংলা কৃষি বিশ্ববিদ্যালয় এবং কিছু বেসরকারী প্রতিষ্ঠান যথা ব্র্যাক, প্রশিকা, লালতীর ইত্যাদি। বাংলাদেশে পরীক্ষা-নিরীক্ষা করার জন্য ফিলিপাইনে অবস্থিত আন্তর্জাতিক ধান গবেষণা ইসস্টিটিউট (IRRI) কর্তৃক জিএম ফসল গোল্ডেন রাইস (Golden Rice) বাংলাদেশ সরকারের অনুমোদন পেয়েছে। বাংলাদেশ ধান গবেষণা ইনস্টিটিউট (BRRI) এর বিজ্ঞানীরা ইরি (IRRI) থেকে পাওয়া জিএম ধানের জাত এর সাথে এদেশে উদ্ভাবিত আধুনিক জাতের ক্রসিং (Crossing) ও ব্যাকক্রসিং (Backcrossing) অব্যাহত রাখছেন। এদেশের উপযোগী খরা (Drought), লবনাক্ততা (Salinity) ও বন্যা (Sub-mergence) সহিষ্ণু জিএম ধান নিয়ে গবেষণা অত্যন্ত গুরুত্বপূর্ন বলে বিজ্ঞানীরা মনে করেন। তাই এসব গবেষণাও

চলছে। বাংলাদেশ সরকার Bt জিন সমৃদ্ধ জিএম বেগুন নিয়ে নিয়ন্ত্রিত পরিবেশে গবেষণার অনুমোদন দিয়েছে এদেশের প্রাইভেট বীজ কোম্পানী লালতীরকে। আবার বাংলাদেশের পেঁপের কিছু জাতে Papaya Ring Spot Virus প্রতিরোধক্ষম কোট প্রোটিন জিন সংযোজিত হয়েছে। তবে এখনও পরীক্ষা নিরীক্ষার মাধ্যমে, অনুমোদন দেওয়া হয়নি (ভূঁইয়া, ২০০৮) ।

খ্রীষ্টপূর্ব দ্বিতীয় শতকে দার্শনিক ক্যাটো বলেছিলেন, "কৃষিতে একটি কাজে যদি পিছিয়ে পড়, তাহলে অন্য সব কিছুতেই পিছিয়ে পড়বে।" আমরাও কি পিছিয়ে পড়িনি? বাংলাদেশের কৃষির ভবিষ্যত চিন্তা করলে বায়োটেকনোলজির চর্চা ও ব্যবহার বিরোধী মনোভাব ত্যাগ করা প্রয়োজন। বায়োটেকনোলজি কাজের জন্য প্রয়োজন দক্ষতাসম্পন্ন বিজ্ঞানী, পর্যাপ্ত জ্ঞান, সরঞ্জাম, রাসায়নিক দ্রব্যাদিসহ একটি পূর্ণাঙ্গ গবেষণাগার। বাংলাদেশে এসব অসম্ভব নয়, তবে রয়েছে নানা প্রতিকূলতা, বাধা এবং বিজ্ঞানীদের যথাযথ পৃষ্ঠপোষকতার অভাব। এসব কারনে অনেক গুণী বায়োটেকনোলজিষ্ট বিজ্ঞানী দেশ ছেড়ে চলে গেছেন। আর তাই বায়োটেকনোলজিতে বাংলাদেশ পিছিয়ে পড়েছে বহুদূর। আমাদের পার্শ্ববর্তী দেশ সহ বহু দেশ দ্রুত এগিয়ে চলেছে এবং জিএম শস্যের আবাদ করে তারা লাভবান হচ্ছে।

বায়োটেকনোলজির ব্যবহারে ঝুঁকি

প্রথম বিজ্ঞান ভিত্তিক কল্প-কাহিনী (Science fiction) উপন্যাস "ফ্রাঙ্কেনস্টাইন" প্রকাশিত হয়েছিল ১৮১৮ সালে লন্ডনে, যার লেখিকা ছিলেন মেরী শেলী। উপন্যাসের নায়ক ড. ফ্রাঙ্কেনস্টাইন তার গবেষণাগারে মৃত মানুষের অঙ্গ-প্রত্যঙ্গ জোড়া দিয়ে জীবন্ত মানুষ তৈরির জন্য একটি তাজা মস্তিস্ক খুঁজছিলেন। শেষে তা পাওয়া গেল। তবে তা ছিল অপঘাতে মৃত এক দুর্ধর্ষ অপরাধীর। সময় ছিলনা ভাল মানুষের মস্তিস্ক খোঁজার। অনেকটা বাধ্য হয়েই তিনি মস্তিস্কটি লাগিয়ে দিলেন দ্রবনে রাখা দেহের মাথার খুলির ভিতর । অত:পর বিদ্যুত তরঙ্গ চালু করলেন দ্রবণের মাঝে। আস্তে আস্তে বুদবুদ ও ঘন কুয়াশার সৃষ্টি হল। দেহটিতে প্রাণের সঞ্চার হল। ড. ফ্রাঙ্কেনস্টাইন দেখলেন, দানবদেহী একটি মানুষ নেমে এলো। মহাশক্তিধর দুর্ধর্ষ সেই দানবের সামনে যা কিছু পড়ছে দুমড়ে উপড়িয়ে যাচ্ছে। কে ঠেকাবে এই ধ্বংসকারী দানবকে ? এই দানবই পরিচিতি লাভ করল তার স্রষ্টার নামে "ফ্রাঙ্কেনস্টাইন" হিসেবে। কালক্রমে ধীরে ধীরে অনেক সিনেমা তৈরী হয়েছে এই "ফ্রাঙ্কেনস্টাইন" নিয়ে। বিজ্ঞানের অপসৃষ্টি হিসেবে "ফ্রাঙ্কেনস্টাইন" শব্দটি ক্রমে ক্রমে প্রবাদ হয়ে উঠেছে (হোসেইন, ২০০৯)।

বায়োটেকনোলজির জেনেটিক ইঞ্জিনিয়ারিং পদ্ধতির মাধ্যমে উদ্ভূত খাদ্যশস্য জিএমও (Genetically Modified Organism) নিয়েও বিতর্ক রয়েছে। আমেরিকার বস্টন কলেজের এক ইংলিশ প্রফেসর জিএমও খাদ্যশস্যকে "ফ্রাঙ্কেন ফুড" নামে অভিহিত করে ১৯৯২ সালে নিউইয়র্ক টাইমস (NewYork Times) প্রত্রিকায় একটি চিঠি লেখেন। এর আগে বিজ্ঞানের কোন আবিষ্কারকে "ফ্রাঙ্কেনস্টাইন" নামের সাথে সরাসরি যুক্ত করা হয়েছে বলে জানা নেই। এমন নাম করনের অর্থ ফ্রাঙ্কেনস্টাইনের সৃষ্ট দানবের মতই জিএম শস্য ভয়ঙ্কর। তবে এই ভীতি ভূতের ভয়ের মতই অস্পষ্ট, যা আমাদের মনে ভীতির সঞ্চার করে অথচ যার কোন বাস্তব প্রমাণ নেই। ধানের একটি জিএম জাত "গোল্ডেন রাইস", যা নিয়ে ইদানিংকালে বিতর্কের ঝড় বয়ে চলেছে। জিএমও বিরোধীদের মতে, মানুষের জন্য হুমকি স্বরূপ এই ফ্রাঙ্কেন ফুড পরিহার করতে হবে। যদিও এই ভীতির কোন বৈজ্ঞানিক ভিত্তি কেউ উপস্থাপন করতে পারেনি (হোসেইন, ২০০৯)।

অগেই উল্লেখ করা হয়েছে, একটি প্রজাতির DNA বা gene অন্য একটি প্রজাতির DNA এর সাথে জুড়ে দেওয়ার প্রক্রিয়াকে Genetic Engineering বলা হয় । এই প্রক্রিয়াতেই ডেফোডিল ফুল গাছের খানিকটা DNA বা gene ধানগাছের DNA এর সাথে জুড়ে তৈরি হয়েছে Golden rice যার চাউলের রং হলদে বা সোনালী । ডেফোডিল গাছের যে জিন বিটা ক্যারোটিন (β-Carotene) তৈরি করতে পারে তা ধান গাছে সংযোজিত হয়েছে। ভিটামিন-এ (Vitamin A)

এর উৎস এই বিটা ক্যারোটিন। তাই Golden rice খেলে মানুষের দেহে ভিটামিন এ এর অভাব পূরণ করা সম্ভব হবে। এই ভিটামিন এ এর অভাবে এদেশে প্রতি বছর অসংখ্য শিশু অন্ধ হয়ে যায় । গোল্ডেন রাইস তাদের অন্ধত্ব হতে রক্ষা করতে পারবে বলে আশা করা হচ্ছে । বিজ্ঞানীরা ইতোমধ্যে আরও বেশ কিছু জিএম শস্য উদ্ভাবন করেছেন যা মানুষের খাদ্য হিসেবে ব্যবহৃত হচ্ছে, যা উপরে বলা হয়েছে।

জিন প্রযুক্তির মাধ্যমে পৃথিবীর যে কোন জীবের কাঙ্খিত জিন আহরণ করে তা ফসলে বা অন্য জীবে এখন সংযোজন করা যায়। সকল জীবের DNA র গঠনে যে আশ্চর্য রকম সাদৃস্য রয়েছে সে কারনেই যে কোন জীব থেকে ফসলে জিন সংযোজন সম্ভব। ব্যাক্টেরিয়া বা ভাইরাসের জিন ফসলে ঢুকিয়ে দেওয়াকে অনেকেই ভাল মনে করছেন না। জিএমও নিয়ে তুমুল বিতর্ক হয়েছে ইউরোপ জুড়ে। ফ্রান্স ও আয়ারল্যান্ডে জিএমও প্রতিবাদীরা শস্যের গাছ উপড়ে দিয়েছে, শস্য গুদামও তছনছ করেছে। অস্ট্রিয়া, লূক্সেমবার্গ, নরওয়েতে জিএমও ভুট্টা চাষ নিষিদ্ধ করা হয়েছে। যুক্তরাজ্যকে ঘোষনা করা হয়েছিল জিএমও মুক্ত দেশ হিসেবে। এমনকি ১৯৯৮ সালে যুক্তরাষ্ট্রে ধর্মীয় নেতৃবৃন্দ ও বিশ্ববিদ্যালয়ের শিক্ষকগণ জিএমওকে অনৈতিক ও অবাঞ্ছিত ঘোষনা করে আদালতে মামলা দায়ের করেছিল।

কিন্তু বর্তমানে যুক্তরাষ্ট্র, আর্জেন্টিনা, ব্রাজিল, কানাডা, চীন ও যুক্তরাজ্য নিজ নিজ জাতীয় খাদ্য নিরাপত্তা যাচাই কৌশল প্রয়োগ করে জিএম ফসল খাবার উপযোগী বলে ছাড়পত্র দেবার পর সেগুলো আবাদ করা হচ্ছে । International Council for Science (ICSU) নামক সংস্থাটি বর্তমানে ব্যবহৃত খাদ্য নিরাপত্তা যাচাই পদ্ধতি সঠিক বলে মতামত দিয়েছে। জরীপের মাধ্যমে ICSU মত দিয়েছে যে, লক্ষ লক্ষ মানুষ জিএম উৎপাদিত খাদ্য খাচেছ কিন্তু ফলে কোন ক্ষতিকর প্রভাব সম্পর্কিত এমন কোন প্রতিবেদন পাওয়া যায়নি (ভূঁইয়া, ২০০৮)।

জি এম খাদ্য নিয়ে আশংকার কারণসমূহ

১। জিএম শস্যের সংযোজিত জিন (Transgene) কর্তৃক সৃষ্ট প্রোটিন খাবারে থাকতে পারে যা বিষাক্ত বা এলার্জির কারন হতে পারে।

২। খাদ্যে পরিবর্তিত মাত্রায় বিষাক্ত উপাদান বা অন্যান্য পুষ্টি থাকতে পারে, যা জীবের জন্য হুমকির সৃষ্টি করতে পারে এবং পরিবেশকে করতে পারে বিপন্ন।

৩। খাদ্যে নির্বাচনক্ষম মার্কার জিন কর্তৃক সৃষ্ট এনজাইম থাকতে পারে।

৪। খাবারে থেকে যেতে পারে এন্টিবায়োটিক প্রতিরোধী জিন, যা মানুষের অন্ত্রে সংশ্লিষ্ট হয়ে এন্টিবায়োটিক প্রতিরোধী হয়ে উঠতে পারে।

৫। নতুন সংযোজিত বৈশিষ্টটি ফসলের সাথে সম্পর্কিত যৌন জননক্ষম অন্য জাতে বা আগাছাতে স্থানান্তরিত হতে পারে।

৬। ভাইরাস প্রতিরোধী জিনের সাথে ফসলে আক্রমনকারী ভাইরাসের রিকম্বিনেশনের (Recombination) এর মাধ্যমে অধিকতর আগ্রসী ভাইরাস উপজাত (Strain) সৃষ্টি করতে পারে।

৭। কীট প্রতিরোধী জিনের কারনে পতঙ্গের উপর যে নির্বাচন চাপ পড়বে সেজন্য নতুন নতুন ক্ষতিকর কীট-পতঙ্গের উদ্ভব ঘটতে পারে। (ভূঁইয়া, ২০০৮)।

জিএম শস্য কি নিরাপদ?

জিএম শস্য থেকে প্রাপ্ত খাদ্য অন্যান্য যে কোন খাদ্যের তুলনায় বেশী পরীক্ষা ও যাচাই করা হয়। বাজারে পৌছানোর পূর্বেই এইসব খাদ্যদ্রব্য বিভিন্ন সংস্থা যেমনঃ বিশ্ব স্বাস্থ্য সংস্থা (WHO) , খাদ্য ও কৃষি সংস্থা (FAO) এবং অর্থনৈতিক সংস্থা ও উন্নয়ন সংগঠন (OECD) ইত্যাদি কর্তৃক প্রবর্তিত আইন সাপেক্ষে যথেষ্ট পরীক্ষা-নিরীক্ষা ও যাচাই করা হয়। দ্রব্য সমূহকে তাদের নিরাপত্তা, এলার্জি, বিষাক্ততা এবং পুষ্টির উপর বিচার বিশ্লেষন করা হয় (ISAAA, 2005)।

জীব নিরাপত্তা (Biosafety) সম্পর্কে চুক্তি

জিএম উদ্ভিদের নিরাপদ স্থানান্তর ও ব্যবহার নিশ্চিত করার জন্য আইনগত বৈশ্বিক একটি প্রোটোকল অবলম্বন করেছে জাতিসংঘের Convention on Bio-Diversity (CBD)|. এটাকে কার্টাহেনা প্রোটোকল অন বায়োসেফটি (Cartagena Protocol on Biosafety) বলা হয়। বর্তমানে বাংলাদেশ সহ পৃথিবীর ১৪০টি দেশ এই জীব নিরাপত্তা চুক্তিতে স্বাক্ষর করেছে। ২০০৪ সালের ৫ই ফেব্রুয়ারী বাংলাদেশ এই প্রোটোকল অনুমোদন করে। চুক্তি স্বাক্ষরকারী প্রতিটি দেশেই আধুনিক বায়োটেকনোলজির উৎপাদন, ব্যবহার ও ছাড়করণের জন্য সংশ্লিষ্ট ঝুঁকিসমূহ যাচাই, ব্যবস্থাপনা ও দমন করার সিস্টেম থাকার প্রয়োজনীয়তার উপর জোর দেওয়া হয়েছে। বিজ্ঞানসম্মত উপায়ে এবং স্বচ্ছতার সাথে প্রতিটি ক্ষেত্রের জন্য আলাদাভাবে (Case by case) ঝুঁকি নিরুপণ করা প্রয়োজন। নিরাপত্তা সংক্রান্ত প্রতিবেদন জনসাধারণের নিকট বোধগম্য করে উপস্থাপন করতে হবে। কোন কিছু বাড়িয়ে বা কমিয়ে না বলে বাস্তবতার মুখোমুখি হওয়া এবং সত্যটাকে তুলে ধরাই গুরুতপূর্ন বিষয়। পরিশেষে বলা যায়, আধুনিক বায়োটেকনোলজির ব্যবহারের সুফল ভোগে কোন দ্বিধা-দ্বন্দ থাকা উচিত নয়। তবে বায়োসেফটি বা জীব পরিবেশের নিরাপত্তা আইন প্রয়োগ করে এই প্রযুক্তি চর্চা বাংলাদেশে করা উচিত।

সূত্রঃ

১। ইসলাম, এ. কে. এম. আর. এবং রহমান, এম. এইচ. (১৯৯৯), বইঃ প্লান্ট বায়োটেকনোলজি, প্রকাশক, মোহাম্মদ হোসেন, ইউরেকা বুক এজেন্সি, নিউমার্কেট, সাহেব বাজার, রাজশাহী।

২। ভূইয়া, এম. এস. আর. (২০০৮), বইঃ জেনেটিক্যালি মোডিফাইড ফসলঃ বর্তমান ও ভবিষ্যৎ, প্রকাশক, ড. আবদুল ওয়াহাব, পরিচালক, পাঠ্যপুস্তক বিভাগ, বাংলা একাডেমী, ঢাকা ১০০০।

৩। প্রথম আলো (দৈনিক সংবাদপত্র), (২০০৮), প্রকাশক, মতিউর রহমান, মিডিয়াস্টার লিমিটেড, ৫২ মতিঝিল বা/এ, ঢাকা ১০০০।

৪। হোসেইন, এম. জি, (২০০৯), Memiograph।

৫। ISAAA (International Service for the Acquisition of Agri-biotech Applications), 2005, Global Knowledge Centre on Crop Biotechnology, SEAsiaCenter, C/o IRRI, Philippines.

A CITATION FOR DR. KAZI M. BADRUDDOZA FOR LIFE-LONG CONTRIBUTION TO AGRICULTURAL RESEARCH AND DEVELOPMENT

(On the occasion of Award of Medals, Crests etc, 2010 by BAAG)

The Fellows of the Bangladesh Academy of Agriculture (BAAG) are extremely honoured to present a gold medal to Krishibeed Dr. Kazi M. Badruddoza, National Emeritus Scientist, NARS- Bangladesh for his extra-ordinary contribution and constant endeavour to improve the National Agricultural Research System of Bangladesh. His untiring efforts after liberation of the country and throughout the seventies and eighties of the last century to reorganize BARC, establish BARI and IPSA (now Bangabandhu Sheikh Mujibur Rahman Agricultural University), Livestock Research Institute and Fisheries Research Institute, in addition to his Significant effort to upgrade INA of BAEC to its national status as BINA along with some of its scientists, account for the phenomenal success of research and development in the country.

As a visionary for agricultural research, he was instrumental to the initiation and quick spread of wheat cultivation in Bangladesh. The Nobel Laureate, late Dr. Norman Borlaug was astonished to observe this and wrote a letter to the Hon. President of Bangladesh on 25 April, 1978 where he said "When I visited Bangladesh less than four years ago, there was no mention of wheat in the national plan. Nevertheless, during the current crop cycle, Bangladesh harvested somewhere between 350,000 to 400,000 acres of wheat, much of it with excellent yield. This is a fantastic accomplishment. It could not have been achieved without the vision and excellent organizational ability of the Director (*now D.G.)* of the Bangladesh Agricultural Research Institute (BARI), Dr. Kazi M. Badruddoza. Under his excellent leadership, he has assembled an excellent, enthusiastic and well-motivated team of wheat scientists". (Ref. Wheat Research and Development in Bangladesh, CIMMYT p.24).

In fact, during about a decade covering seventies and eighties of the 20th century, the name Kazi M. Badruddoza was almost synonymous to agricultural research in Bangladesh. This was so because of his constant struggle to establish infrastructures and facilities for agricultural research on the one hand, and consolidation of such a divergent group of ten research institutions under one umbrella, BARC, on the other. The establishment and consolidation of the present day NARS is an outcome of almost his single-handed efforts over a period of two decades.

It is recorded with utmost reverence and gratitude that his professional leadership in the agricultural research system of Bangladesh over two decades has been of the highest quality and that is reflected in the number, size and scientific quality of the NARS institutes. Performance of these institutes in increasing agricultural production in the country has already been recognized internationally.

A life time of service of Dr. Kazi Badruddoza is amazing indeed. He joined in the former Agricultural Research Institute (ARI) in 1948. He has been serving the cause of agricultural research till today when he is 84 years old. His life is a story of vision, determination, hard work, persuasion, persistence and, above all, a passionate dedication to improve agricultural research in the country to produce abundant food for the countrymen. He has endured much as well as accomplished much, and he still continues to travel everyday to reach institutions like BARC, BAS, BAAG etc. pursuing his mission, inspiring each of us by his presence. To cut a long and eventful story of arduous struggle into a short one, I must add that, anyone, who ever heard him speak, knows that he is passionate about his convictions, persistent in going after his goals, and indeed a master persuader articulating those goals into reality.

We, the Fellows of BAAG, emphatically recognize his priceless contribution for the cause of agricultural research and pray for his long life with the fondest gratitude.

The Bangladesh Academy of Agriculture is conferring the "Gold Medal for Life-Long Contribution to Agricultural Research and Development 2009" upon Dr. Kazi M. Badruddoza.

Written by: Dr. M. Anwarul Quader Shaikh

CITATATION ON AWARD OF HAJI MUSLIM-KHURSHIDA GOLD MEDAL 2009 OF BANGLADESH ACADEMY OF AGRICULTURE TO **DR. SALINA PARVIN BANU**

This citation is in recognition to the contribution of Dr. Salina Parvin Banu, Principal Scientific Officer of Plant Genetic Resources Centre, Bangladesh Agricultural Research Institute (BARI) in developing **"Healthy Seedlings"** technology to increase agricultural productivity.

Poor soil-biological health and increased demand of fertilizers are issues of low productivity in many developing countries including

Bangladesh. This fundamental constraint undoubtedly limits the effectiveness of other yield enhancing technologies. Very few appropriate technologies are available for resource poor farmers to address these problems. Dr. Banu developed the technology of production of "Healthy Seedlings" through soil solarization for the first time to increase rice productivity. She conducted exensive diagnostic participatory research in farmers' fields and at BARI farm sites, set up demonstration trials, and hosted outreach programmes for farmers from 1996 to 2002 in rice-wheat cropping systems. The key areas of her investigation were improvement of root/soil health through soil solarization at the field level as well as at nursery beds, and integration of solarization with seed treating fungicides Vitavaz-200™.

Dr. Banu's research describes solarization of seedling nurseries (i.e. covering the soil with clear/transparent plastic for four weeks during the hot, dry season) as a simple, low cost, non-chemical soil treatment method to create nematode and pathogen free soil environment producing vigorous "Healthy Seedlings" of rice.

In her research, inorganic soil nitrogen was found to increase by a factor of 1.7 – 2.4 and available manganese by 3.8 times after solarization. Increase of nitrogen mineralization reduced top dressing of urea: a single topdressing in monsoon rice instead of three (Banu et al, 2002) was sufficient. Simultaneously, weed growth in wheat decreased by 2.7 to 5.0 folds (Banu et al., 2005). Chlorophyll content and seedling height were higher in unfertilized, solarized seedbed over the non-solarized seedbed (Banu et al., 1998 & 2001).The "Healthy Seedlings" technology generated large impacts on productivity of rice. Yield increase was 18% at farm level in Gazipur and 42% in Dinajpur district.

Dr. Banu identified the long term positive effects of single soil solarization in summer for three successive crops (spring rice-wheat-monsoon rice) by reducing soil borne pests like *Bipolaris* spp., *Carvularia* spp., Fusarium spp., Sclerotium spp. and nematodes. The change in chemical and microbial factors of soil was reflected in significant growth response, i.e. increased biomass, plant height and chlorophyll contents of these successive crops.

Thus, the new technology provided the opportunity for reduced use of chemical fertilizers (especially urea), pesticides and herbicides, in addition to producing vigorous healthy seedlings. Dr. Banu along with her team developed promotional packages to be used in dissemination of the technology. Dr. Banu's technology is posted in the Rice Knowledge Bank of the International Rice Research Institute (IRRI), Philippines for dissemination in rice growing countries of the world. The technology is in up-scaling process in Thailand. Yield response ranged from

9% – 23 % over conventional practice in demonstration trials.

The development of the "Healthy Seedlings" through solarization is a simple, effective and easily understandable agricultural practice for resource poor farmers. This would help improve their livelihood and food security through increased productivity.

In view of her contributions, the Bangladesh Academy of Agriculture (BAAG) is conferring the Haji Muslim-Khurshida Gold Medal 2009 on Dr. Salina Parvin Banu.

Written by: Dr. M. Gul Hossain

CITATATION ON AWARD OF CREST OF MERIT 2009 OF BANGLADESH ACADEMY OF AGRICULTURE TO DR. SYED NURUL ALAM

This citation is in recognition to the contribution of Dr. Syed Nurul Alam, Principal Scientific Officer of the Entomology Division, Bangladesh Agricultural Research Institute (BARI) for improving and promoting IPM technologies in Bangladesh using sex pheromone.

Vegetable production in Bangladesh is beset with high and unsustainable use of pesticides. With widely abused pesticides, farmers and consumers are exposed to poisonous chemicals and their residues in diets and in the environment. Dr. Syed Nurul Alam along with his team at BARI promoted and extensively used IPM technologies, based on sex pheromone developed elsewhere, for a good number of vegetable crops. Farmers in Bangladesh have benefited highly by the use and adoption of pheromone based IPM technologies. Dr. Alam has been deeply involved in conducting effective IPM programs and in promoting their adoption.

In recognition to the the contributions, the Bangladesh Academy of Agriculture is conferring the Crest of Merit 2009 to Dr. Syed Nurul Alam.

Written by: Dr. M. Gul Hossain

CITATATION ON AWARD OF CREST OF MERIT 2009 OF BANGLADESH ACADEMY OF AGRICULTURE TO MR. MUHAMMAD ZAHER

This citation is in recognition to the contributions of Mr. Muhammad Zaher, Chief Scientific Officer of Bangladesh Fisheries Research Institute, Chandpur for significant contribution to aquaculture and fish feed development technologies.

Some of the important technologies developed by Mr. Zaher are:

- Development of six species-combination carp polyculture
- Development of low cost quality fish feed utilizing locally available materials
- Development of low cost pellet machine for fish farmers for pellet feed production

Large scale extension of culture of popular local carps, *pangas* and *koi* fish has been possible due to the development of appropriate culture and feeding technologies.

The development of pellet machine rapidly attracted large scale fish farmers leading to commercial fish farming in Bangladesh at a time when the existence of local fish species became threatened.

Mr. Zaher has prepared Fish Feed Reference Standards for Bangladesh .that has served as the basis for the Fish Feed Act being developed by the Government of Bangladesh.

In recognition to the contributions, the Bangladesh Academy of Agriculture is conferring the Crest of Merit 2009 on Mr. Muhammad Zaher.

Written by: Dr. M. Gul Hossain

CITATATION ON AWARD OF CREST OF MERIT 2009 OF BANGLADESH ACADEMY OF AGRICULTURE TO BANGLADESH FOREST RESEARCH INSTITUTE

This citation is in recognition to the contribution of Bangladesh Forest Research Institute for outstanding research on bamboo propagation, preservation and utilization.

The scientists of different disciplines of the Bangladesh Forest Research Institute, through their protracted efforts, developed bamboo propagation techniques using branch cutting, seedling multiplication and tissue culture of different species of bamboo.

The method of chemical preservation of bamboo developed at the institute increases service- life of bamboo by 3-4 folds. This technology has also been used for enhancing the service-life of jute stick used for betel leaf cultivation. Based on the technology small scale entrepreneurs have established preservation centres in Barisal and Chittagong regions.

Bangladesh Forest Research Institute (BFRI) in collaboration with entrepreneurs have developed products from bamboo that include furniture, handicrafts, bamboo cemented boards as housing materials.

As scientists of different disciplines were involved in the process, the Bangladesh Academy of Agriculture is conferring the Crest of Merit 2009 on the Bangladesh Forest Research Institute (BFRI).

Written by: Dr. M. Gul Hossain

Tribute to Late Krishibeed Yasin Ali

M. Hassanullah
B.Ag. M.Sc.(Ag), MS, Ph.D.

Late Yasin Ali (former Director, Sugarcane Research & Training Institute), a dedicated Krishibeed (Agricultural Expert), made a wide range of contribution for the welfare of farmers and Krishibeeds during early sixties to till his death. He should be remembered for his significant contributions to four splendid works namely,

- Revitalizing sugar industry
- Introduction of intercropping & STP
- Intensive production programs of early seventies
- Acting as a great mentor of Krishibeeds

Publication of his book on, "Problems and Prospects of Sugar Industry" triggered revitalization of sugar industry leading to creation of the Directorate of Sugarcane in the Sugar & Food Industries Corporation and eventually leading to his appointment as Sugarcane Agronomist. Being Sugarcane Agronomist he authored 4 schemes which were the life blood of sugar industry:

- Intensive cane development
- Farm modernization
- Sugarcane Research Institute
- Staff training institute

He got those schemes implemented through strong pressure created by lobbing and manipulation from the Planning Commission in spite of tooth & nail opposition from the very power structure of the corporation. Implementation of those schemes rescued the sugar industry from its

perilous condition of early seventies and eventually made the country self sufficient in sugar in early eighties when BSFIC could even export 30,000 tons of sugar in 1982.
He was the first person who picked up intercropping as means of increasing cropping intensity and institutionally adopted target of area of intercropping in early plantation of sugarcane as a key innovation of sustaining sugarcane cultivation. Subsequently, intercropping became customary in crop production everywhere in the country.

He invented STP (space transplantation) technique of sugarcane and tried to get it accepted and supported by BSFC for dissemination among sugarcane growers till his death. I have heard that BSFIC of late accepted the technique as means of increasing yield and support farmers for its adoption with credit after his death. Had this technique been accepted by BSFIC before his death his departed soul would have been resting with peace.

He must be remembered for his contribution to intensive crop production programs of seventies. His concept and operation of intensive cane development program in early seventies triggered to undertake intensive jute production, intensive wheat production, intensive rice production, intensive minor crop production, coordinated oilseed production program, etc.

He was the inventor of the word "Krishibeed". There is no way to forget his two decades' relentless efforts (1962-1978) for rehabilitation of Krishibeeds in their rightful place in the society. He never gave up or compromised with the interest of Krishibeeds. He played significant role in improving curriculum of agricultural education to upgrade of technical capacity of the graduates so that their salary grades are not devaluated, salary equation with doctors and engineers and services re-organization to create and expand the employment opportunities of the agricultural graduates.

He was a relentless persuader. There were no limits of his persuasions in terms of time, hierarchy or organization or persons. For example, to do something in DAE he used to persuade everybody from Upazila Agricultural Officers to Director General and continued to do so year after year. He persuaded the BSFIC to accept the STP technology of sugarcane cultivation till his death and persuaded from ACDOs to the Honorable President to persuade the BSFIC for its acceptance. During early seventies to the time of his death no senior officer of agriculture will be able to say that Mr. Yasin did not visit him requesting for doing something for agriculture or agricultural graduates. Now there is none to knock at the door to do this or that for agriculture. Let his departed soul remain in peace by the grace of the Almighty Allah, the Merciful.

BAAG AND ITS ACTIVITIES

BANGLADESH ACADEMY OF AGRICULTURE

(An institution of senior agriculturists promoting agricultural science)
C-3, South, Centre Point, Farmgate,
Dhaka-1215. Tel: 8124549.
E-mail : bag@citechco.net

Introduction
Bangladesh Academy of Agriculture, a non-government professional organization of senior agriculturists, was established in June 1994.
Agriculture, especially the crop sector, has made a siginigicant stride towards achieveing food self-sufficiency. Meeting the needs of the large and growing population (currently about 14 million people) for food, fibre, fuel, fisheries and foresty from the limited land resource (a total of 144,000 square kilometer) still remains a daunting challenge.
The country, once proud of its National Agricultural Researche System (NARS), has been experiencing an erosion of its scientific manpower, decling funds for research and development vis-à-vis the aggravating rural unemployment, poverty and malnutrition. Productiveity of crops per unit land area is still very low and the gag between the potential and the realized crop yields is considerable.
More than 25% of the GDP still comes from agriculture, the sector that provides employment to 78% of the workforce (BBS 1999). The development of the agriculture sector, accompanied by an equitable distribution of income earning opportunities, provides the answer to the widespread unemployment, poverty and malnutrition that prevail in the country.

The Challenge Ahead
The increasing population : The World Bank estimates that the population of Bangladesh will reach 190 million by 203 A.D. Even at the present level of calorie intake (2000 keal/capita/day), the cereal requirement by 3020 A.D, will be about 40 million tones, against 25 million tones at present.
Food Crops: The above projection warrants a cropped area of more that 33 million hecters with a highly intensive cultivation system. This means that the country will have to produce about twice as much cereal food grains from its land only to maintain the current level of low calorie intake.
Fisheries: The fish requirement in 2030 A.D. is estimated at more than 2 millon tones, about three times of the quantity available at present. The country is striving to meet the deficiency in fish protein through

culture fisheries that needs a concerted support.
Livestock and Poultry: Currently the deficit of meat and milk is about 55 and 58 percent respectively. The cattle population in farm households has declined shaply due mainly to scarcity of feeds and fodder. Whaile the livestock scenario is disappointing, small-scale popultry farms are coming up to meet the domestic demands for meal and eggs.
Forestry: The official figure for forest cover is about 16% (i.e. 1.53 million hectares) of the total land area of the country. However, according to informed sources, the forest area has reduced to about 6%. Illegal deforestation of resered forests and demudation of tree covers in homesteads and village groves have led to serious problems not only in meeting domestic fuel and timber demands, but also on the ecology and the environment.

Facing the Challenge
The way open to face the challenge is a rapid development of science-based agriculture and efficient use of technologies at the farm level, keeping in view the sustainability of the production base.

Problem areas
1. Technology generation and dissemination.
2. Low production at the farm level.
3. Faulty marketing system.
4. Degradation and depletion of natural resource based.
5. Subsistence agriculture.
6. Development of human resources.
7. Grass-roods participation in rural R&D.

The Need for Innovative Efforts
From the foregoing discussion, three main dimensions of rural cum agricultural development can be identified:
- Technical and physical dimention,
- Financial and economic dimensions;
- Human and institutional dimensions;

The pattern of our rural and agricultural development would, therefore, warrant focused attention on:
- Science-based appropriate technology;
- Ecological sustainability;
- Economic efficiency with equity (including gender balance);
- Human resources development,
- Grass-roots level institution building for production and utilization.

These needs and challenge warrant innovative efforts which the public sector lacks. It is thus expedient to promote professional institutions and the private sector for innovative efforts for a balanced development of commercial agriculture, withour aggravating landlessness, rural unemployment and prverty.

Bangladesh Academy of Agriculture
In this backgrounbd, a group of professional agriculturists volunteered to form a non-profit society in the name of Bangladesh Academy of Agriculture (BAAG) with a view to addressing the above needs and challenges.

Scope
The headquarters of the academy shall be located in Dhaka, the capital of Bangladesh, with its operational jurisdiction all over Banladesh. The Academy shall cover, within its activities, areas of Crop Husbandry, Animal Husbandry, Fisheries, Forestry, Agro-industires and allied activities.

Objectives
The Academy shall aim at:

- Promoting ecological sustainable agriculture;
- Recognizing and supporting excellence in research, teaching and practice of agricultural science;
- Assisting the government in policy and programme planning for agricultural development;
- Assistding local NGOs companies and agencies for better services to farmers; condueting specific studies and publishing
- Documents for advancement of agricultural science;
- Participating at international scientific work in agriculture;

Membership
A member of the Academy is designed as a Fellow. Subjects to fulfillment of the terms and conditions and payment of dues and fees, as prescribed by rules and by laws, the membership of the Academy is extended to eminent Agricultural Scientists of maintain of 45 years of age.

Funds
Fees, donations, gifts, subscriptions, grants, income from investments, overhead charges from projects and all other cash receipts constitute the funds of the Academy. Receipts against projects and trusts are treated as Project and Trust Funds respectively. Receipts used for procuring movable and immovable properties of incurring expenditure solely for the fulfillment of the aims and objectives of the academy.

Publication
The academy publishes a scientific journal in the name of the "Banladesh Agriculture". The Academy also publishes books and documents as and when required for the advancement of agriculture. It already published two books, namely, indigenous of Technologies of Agriculture in Bangladesh and Agriculture Research in Bangladesh in the Twentieth Century.

Programmes
The Academy provides services for the improvement of crops, livestock, fisheries, forest, agri-business, rural development, poverty alleviation and sustainable agricultural development. Currently the following seven programme areas have been identified.

1. Agribusiness Technology Development.
2. Contractual Researches.
3. Contractual Advisory Services
4. Human Resource Development
    a. Agricultural Research Management.
    b. Management of Extension Service
    c. Agricultural Resources and Agro-management
    d. Farm and Home Management
    e. Commercial Ventures
5. Rural Development and Poverty Alleviation
6. Promotional and Review Activities.

PROJECT IMPLEMENTED
The following projects were implemented until the year, 2001 A.D.

- ➢ Indigenous Technologies of Agriculture in Bangladesh.
- ➢ Agricultural Production after the 1998 flood. Farmer's Role and Experience in Technology Adoption and Innovation.
- ➢ Present Status of Deep Water Rice in Bangladesh.
- ➢ An Assessment of Agro-forestry Activities by NGOs.
- ➢ Study on the Status of Seed Production and Marketing in Bangladesh.
- ➢ Demonstration of Late Jute Seed Production (LJSP) Technology of BJRI Tossa Pat-3 (OM-) at Farmer's Field.
- ➢ Agricultural Research Management Project;
    1. Plant Genetic Resources of Bangladesh (Wild and Cultuvated).
    2. Instrumentation System of the NARS institutes.
    3. Human Resource Development Plan 2020 for the National Agricultural Research System.
- ➢ Small Studies to Reiew and Assess the Effectiveness of Research Programme, Technical Assistance and Training Programme.
- ➢ Studies on the 100 years of Chronological Development of Agricultural Research in Bangladesh.

Establishment of the Centre for Agriculture and Rural Development (CARD) at Moheswar Chanda, Jhenaidah;
CARD is the first R&D Institution in Bangladesh managed by farmers. It was established by BAAG in 1997 and received assistance from Canada, Germany and other countries. The objective is group approach and participatory R&D.

FELLOWS

Kamal Uddin Ahmed
B.Ag. (DU); M.Ag. (DU); M.S. (USA); Ph.D. (USA)

Munshi Siddique Ahmed
B.Ag. (DU); M.Ag. (DU); M.S. (USA); Ph.D. (USA)

Late M. Afsar Uddin
B.Ag. (DU); Agr. Sc. (Hon); Newzealand.

Late Noazesh Ahmed
B.Ag. (DU); M.S. (USA); Ph.D. (USA)

Mohammed Shamsul Alam
B.Ag. (DU); M.Sc.Ag. (BAU); Ph.D. (USA)

A.H.M. Altaf Ali
B.Ag. (DU); M.S (Japan); Ph.D. (USA).

Kazi M. Badruddoza
B.Ag. (DU); M.Ag (DU); Ph.D. (USA).

Late M. Sujayet Ullah Chowdhury
B.Ag. (DU); M.S (Japan); Ph.D. (UK).

Somen Dewan
M.Sc., Ph.D.

Muhammad Golam Ali Fakir
B.Ag. (DU); M.Ag (DU); Ph.D. (USA).

Abdul Halim
B.Ag. (DU); M.Sc. Extn. Edn. (BAU); Ph.D. (Phi).

M. Abdul Haque
B.Ag. (DU); M.Ag. (DU); Ph.D. (USA).

Mohammad Abdul Hasnath
B.Ag. (DU); M.Ag. (DU); Ph.D. (USA).

M Hasanullah
B.Ag. (DU); M.Sc.Ag. (BAU); M.S. (AUB)Ph.D. (DU).

S.M. Hasanuzzaman
B.Sc. (Agri); B.Ag. (DU); M.Ag. (DU); M.S. and Ph.D. (USA).

Md. Ameerul Islam
B.Ag. (DU); M.Ag.(DU), M.S. (USA); and Ph.D. (Philippines)

A.J.M. Azizul Islam
B.Ag. (DU); M.Ag. Ph.D. (USA).

Md. A. Jalil
B.Ag. (DU); M.Sc. Ag (BAU).

M.N.A Katebi
B.Sc. (Hons) and M.Sc. (DU); M.Sc. (Pak); M.S. (USA).
Late Abdul Baten Khan
B.Ag. and M.Ag. (DU); Ph.D. (UK); D.I.C (ICST).

Mohammad Hossain Mondal
B.Ag. (DU); M.Ag. (DU); M.S. Ph.D. (USA).

Late Shikh Golam Mahboob
B.Ag. (DU); M.S and Ph.D. (USA).
Lutfur Rahman

B.Ag. (DU); M.Ag. (BAU); Ph.D. (Prag.).

Md. Ayubur Rahman
B.Ag. (DU); M.Sc. (Ag.)(BAU); Ph.D. (Australia).

Abu Musa Muhammad Tareque
B.Sc. (Vet. Sc. & AH) (BAU); M.Sc. (AH)(BAU); Ph.D. (PAU).

M. Gul Hossain
B.Ag. (DU); M.Sc.(Ag.) (BAU); Ph.D. (UK).

Late S.M. Elias
B.Ag. (DU); M.Sc. (BAU); Ph.D. (UK).

M. Anwarul Quader Shaikh
B.S. and M.S. (AUB); Ph.D. (UK).

A.K.M. Amzad Hossain
B.Ag. (DU); M.S and Ph.D. (UK).

Zahurul Karim
B.Sc (Ag); M.Sc.(Ag.) (BAU); Ph.D. (UK).

M. Enamul Huq
B.Sc (Ag); M.Sc.(Ag.) (BAU)

M.A. Mazid
B.Sc (Hons); and M.Sc. (BAU); M.S. and Ph.D. (Japan).

M.A. Razzaque
B.Sc. (Raj); B.Ag. (DU); M.Sc (Ag.) and Ph.D (BAU)

Mr. Farid Uddin Ahmed
M.Sc. (DU, PFI.UK)

M. Motlubur Rahman
B.Sc (Ag), M.Sc (Ag), Ph.D (Philippines)

M. Shahidul Islam
B.Sc (Ag), M.Sc. (Soil Science) Ph.D (Scotland)

Jahangir Alam
Ph.D (Ag.Eco)

M Ali Akbar,
B.Sc (AH) M.Sc (Animal Nutrition), Ph.D (UK)

F.M. Maniruzzaman
B.Ag (DU), M.Sc (Ag), M.S (AUB), Ph.D. (India)

Md. Amin Uddin Mridha
B.Sc. (Hon), M.Sc Ag (BAU)
Ph.D, DIC (London)

Mr. Mohammed Masum
B.Ag, M.Sc (Ag)

Mr. Md. Al Haj Ghaziul Huq
M.Sc (Ag) Agronomy.

Delwara Khanam
B.Sc Ag. (Hons), M.Sc (Ag),
Ph.D (BSMRAU)

Wais Kabir
Ph.D (Ag. Engr)

Professor Md. Ismail Hossain Mian
B.Sc. M.Sc (Ag), Ph.D (USA)

Associate Fellows:

Mahbubur Rahman
M.Sc. Agri., Ph.D. (India)

MAJOR EVENTS OF BAAG DURING 2009

1. Publication and Distribution of Copies of BAAG Journal, "Bangladesh Agriculture" Vol. 2 No. 1 January 2008 issue.

The Volume 2 (1) of the journal was published and copies of were distributed to: Concerned Ministres, Agencies, Departments, NGOs, Universities, Colleges, Research institutes and Fellows of BAAG. The strenuous effort employed by the Editor Dr. M. Anwarul Quder Shaikh in publishing the journal was appreciated by the Executive Council of BAAG.

2. Donation of Alhaj Mohammad Masum, Chairman, Supreme Seed Company

The donation of Tk.1,00,000.00 (Taka One Lac) was received from Alhaj Mohammad Masum, Chairman, Supreme Seed Company Ltd in July, 2009. The Executive Council expressed its thanks to Alhaj Masum for his generous donation.

3. BAAG's Round Table Discussion 2009, and Award of Gold Medal and Crests of Merit

BAAG"s Round Table Discussion 2009 was held in the BARC Conference Room 1 on February 13, 2010. Dr. M. Motlubor Rahman introduced the topic **"Input Supply and Management: Problems and Issues"** and Dr. Wais Kabir, Executive Chairman of BARC, presided over the discussion. About 70 guests artended the Round Table Discussion and took part in the discussion.

4. Award of Medals, Crests etc. for outstanding Contribution to Agricultural Research and Development.

On the same occasion, **BAAG's Haji Muslim-Khurshida Gold Medal 2009** was awarded to **Dr. Salina Parvin Banu** of the Bangladesh Agricultural Research Institute (BARI) for her research on "Production of Healthy Seedlings through Soil Solarisation" In addtion, **Crests of merit** were awarded to (i) Dr. **Syed Nurul Alam** of BARI for "Adapting IPM Technology in Bangladesh Using Sex Pheromone; (ii) **Mr. Mohammad Zaher** of BFRI, Mymensingh for "Development of Low Cost Quality Fish Feed Utilising Locally Available Ingredients" and "Development of Low Cost Pellet Machine for Production of Pellet Feed by Fish Farmers"; and to (iii) **the Bangladesh Forest Research Institute** for "Outstanding Research on Bamboo Propagation, Preservation and Utilisation".

BAAG's Prestigeious Gold Medal 2009 for Life-long Contribution to Agricultural Research and Development was awarded **to Dr. Kazi M. Badruddoza.** The medal was sponsored by Dr. M. Motlubor Rahman. Dr. Kazi M. Badruddoza later donated the medal to BAAG for giving it to someone in future for life- long contribution to agricultural research.

5. Election of New Fellows for the year 2009-2010

The New Fellows elected during the year were:

1. Dr. Wais Kabir, Executive Chairman, Bangladesh Agricultural Research Council
2. Dr. Delowara Khanam, Principal Scientific Officer, BARI,
3. Professor Md. Ismail Hossain Mian, Professor of Plant Pathology, BSMRAU, Salna, Gazipur, and
4. Alhaj Md. Gaziul Huq, Former General Manager (Seed), BADC.

6. Election of BAAG's Executive Council (2009-2010).

The election of BAAG's Executive Council was held on April 07, 2010. Mr. M. Enamul Hoque, a distinguished Fellow of the Academy, acted as the Election Commissioner.

BANGLADESH AGRICULTURE

Volume 3 Number 1 January 2010

Table of Contents

Subject	*Page*
1. Supply and Management of Agricultural Input: Problems and Issues. By - M. M. Rahman	1-13
2. Supply and Availability of Fertilizers as well as Soil Fertility Status and Its Management in Bangladesh. M. S. Islam	14-41
3. Strategic Decisions in Transformaing Subsistence to Commercial Agriculture in Bangladesh. By - M. Hassanullah	42-54
4. Human Follies for Progress and the Endangered Environment: Pointers to the Policy Planners By -Kazi M. Badruddoza and F. M. Maniruzzaman	55-60
৫. কৃষি উন্নয়নে বায়োটেকনোলজির ব্যবহার ও ঝুঁকি By - নীলুফার ইয়াসমিন শেখ	৬১-৭০
6. A Citation for Dr. Kazi M. Badruddoza for life-long Contribution to Agricultural Research and Development.	71-77
7. BAAG and Its Activities.	78-84