

## Research findings

### III Balanced fertilization for increasing and sustaining crop productivity

IPI-BFA-BRRI International Workshop, Hotel Razmoni Ishakha, Dhaka, Bangladesh, 30 March – 1 April 2008. Short abstracts from the symposium.

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#### Introduction

The international workshop on “Balanced fertilization for increasing and sustaining crop productivity” was held in Dhaka, Bangladesh on 30 March – 1 April 2008. This event was conducted under the sponsorship of IPI and the Bangladesh Fertilizer Association (BFA). The Bangladesh Rice Research Institute (BRRI) also actively participated as a co-organizer. The workshop focused on discussing balanced fertilization, particularly in the context of potassium nutrition and its effect on soil fertility, yields, quality, and sustainability of agricultural systems. Prominent national and international scientists delivered presentations, including leading specialists from the International Rice Research Institute (IRRI, Philippines), Netherlands Development Organization (SNV), Potash Research Institute of India (PRII), Tamil Nadu Agricultural University (TNAU, India), Fertilizer Association of India (FAI), BRRI, Bangladesh Agricultural Research Institute (BARI), Bangladesh Agricultural University (BAU) and University of Dhaka (UD). The workshop papers were published in a special issue of the Bangladesh Journal of Agriculture and Environment (Vol. 4, 2008).

Mr. A. Huq, President, Federation of Bangladesh Chambers of Commerce and Industry opened the inaugural session. Mr. K.U. Ahmed, Chairman,

(1) Technical Advisor, Bangladesh Fertilizer Association.

(2) IPI Coordinator East India and Bangladesh.

BFA; Dr. M.A.M. Miah, Head, Soil Science Div., BRRI; IPI Director and Regional Coordinator also delivered a welcome address. Dr. C.S. Karim, Advisor, Ministry of Agriculture of Bangladesh closed the workshop as the chief guest of the valedictory session.

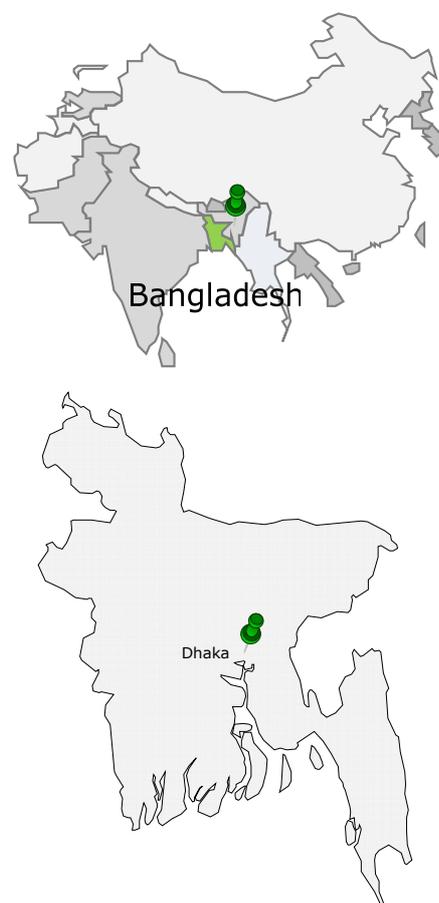
#### Session I: Agricultural policies and their impact on fertilizer consumption

**Dr. B.A.A. Mustafi (BRRI)** presented a paper on “**Development of agricultural policies in Bangladesh**”. He emphasized that agriculture is the driving force of the Bangladesh economy, contributing about 21 per cent to the country’s GDP. In order to achieve the GDP growth rate of six to seven per cent per year, Bangladesh agriculture must grow by at least four per cent per year. This is possible only through the increase in agricultural productivity based on modern agricultural technology. It is one of the major objectives of the National Agricultural Policy. The expansion of modern agricultural practices together with intensified cultivation leads to increasing demand for fertilizers. Thus, emphasis should be given on procurement and distribution of fertilizers in both private and public sectors. Moreover, steps should be taken to maintain a fertilizer buffer stock at regional and district levels. A constant monitoring of supply, storage, price and quality of fertilizers at various levels is also strongly required.

“**Outlook for fertilizer consumption and food production in Bangladesh**” was the title of the presentation made by **Dr. A.L. Shah (BRRI)**. According to recent estimates, about 5.1 million tons more rice will be needed to feed the growing population of the country in 2009-10 as compared to the baseline of 2006-07 (29.75 million tons of rice). The estimated requirement of mineral

fertilizers for only rice production to the year 2009-10 is about 2.0 million tons for urea, 0.4 million tons for TSP and 0.3 million tons for MOP. This volume of potash fertilizers is very close to the current level of MOP consumption in the country but across all crops. Thus, there is a considerable potential for developing balanced fertilization in Bangladesh.

**Dr. R.K. Tewatia (FAI)** in his paper on “**Emerging aspects of balanced fertilizer use in India**” pointed to a remarkable growth in fertilizer application in India to about 114 kg/ha in 2006-07. The Government and industry make concerted efforts to encourage balanced use of fertilizers with a target to achieve the NPK ratio of 4:2:1 at national level. However, the country is now facing various problems including inadequate and imbalanced



Maps of SE Asia and Bangladesh.

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fertilizer use, a distorted NPK consumption ratio, wide interstate/district variation in fertilizer consumption and nutrient mining leading to multinutrient deficiencies. Moreover, increasing deficiencies of secondary and micronutrients have started to decrease the response of applied NPK. Hence, the adoption of fertilizer best management practices should be encouraged in view of low fertilizer use efficiency and declining factor productivity. Extension agencies should ensure that farmers use fertilizers in accordance with soil and crop requirements and deficiency of any nutrient does not become a limiting factor in achieving optimum yields.

### Session II: Integrated nutrient management in rice-based cropping systems

A presentation on “**Implementing field-specific nutrient management in rice-based cropping systems**” was made by **Dr. R. Buresh (IRRI)**. Scientific principles for optimally supplying rice with essential nutrients under the site-specific nutrient management (SSNM) approach were discussed. This approach enables rice farmers to tailor nutrient management to the specific conditions of their fields through the pre-season determination of crop needs for fertilizer N, the within-season distribution of fertilizer N to optimally meet crop needs, and the pre-season determination of fertilizer P and K rates to match crop needs and maintain soil fertility. The optimal fertilizer N rate typically ranges between 40 to 60 kg N per metric ton of

increase in grain yield obtained from N fertilization. The leaf color chart (LCC) is a tool for dynamically adjusting the within-season rates and timing of fertilizer N to match the spatial and temporal needs of the crop for N. Fertilizer P and K rates are determined with a range of tools including soil testing, nutrient omission plots, historical fertilizer and nutrient addition plots. The IRRI website ([www.irri.org/irrc/ssnm](http://www.irri.org/irrc/ssnm)) features the principles for nutrient management and techniques for implementing SSNM.

**Dr. S.K. Bansal (PRII)** delivered a lecture on “**Integrated nutrient management in rice-wheat systems of Indo-Gangetic Plains**”. The notion of declining efficiency of fertilizer use in rice-wheat systems in South Asia was considered by Dr. Bansal as overly simplistic. Apparent diminished returns from increasing fertilizer applications in



**Dr. M.S. Islam** was born in 1946 into a farming family in Gaibandha, a northern district of Bangladesh. Shortly after obtaining an MSc (Ag.) in Soil Science from the Agricultural University of East Pakistan (now Bangladesh), he joined the Bangladesh Agricultural Development Corporation. After serving one year he then moved on to the Bangladesh Agricultural University where he was appointed as a lecturer in Soil Science. In 1973 after being awarded a Commonwealth Scholarship he studied at the University of Aberdeen and obtained a PhD degree in Soil Science in 1976. Before returning to his post in the Bangladesh Agricultural University, his postdoctoral studies continued in Aberdeen, then later in the University of Ghent, Belgium where he was responsible for the development of a modern soils laboratory.

In 1978 Dr. Islam joined Bangladesh Agricultural Research Institute (BARI) as Principal Scientific Officer in the Division of Soil Science where he built up a modern soil and plant analysis laboratory in the Division which has served as a lead laboratory in the country. In his work in the Institute he initiated integrated nutrient management and maximum yield research in the country. He also acted as Principal Investigator of many contract research projects of USAID, World Bank, FAO, PPI-PPIC, including a Canadian CIDA-funded project on Potassium Studies in Soils and Crops of Bangladesh. He was promoted to Chief Scientific Officer; Director (Research) then later to Director General, the post from which he retired in 2004. At BARI Dr. Islam also served as Director for Tuber Crop Research Centre and Director for Administration. Dr. Islam was also deputed to the Bangladesh Agricultural Research Council where he worked three years as Member-Director (Soils).

Dr. Islam is now serving as Technical Advisor to Bangladesh Fertilizer Association (BFA) which publishes the Bangladesh Journal of Agriculture and Environment twice yearly. He is also Chief Editor for the Bangladesh Journal of Progressive Science and Technology.

Besides BFA activities, Dr. Islam has promoted renewable energy through Grameen Shakti, an NGO, and is also a faculty member at the State University of Bangladesh in the Department of Environmental Science

Dr. Islam has visited many countries in the world, attending and contributing to seminars, symposia, conferences and workshops. To his credit, he has published more than 220 scientific research articles dealing with soils, fertilizers, soil chemistry, plant nutrition, environment, and renewable energy.

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the region may be explained by the imbalance in the supply of NPK with application of K often being too low. Changes in soil fertility under rice-wheat cropping, resulting in yield decline, are widely reported. These include decreases in soil organic matter and declines in soil N, P, K and S supply as well as declines in the content of available Zn, B, Cu, Fe and Mn. It was demonstrated that spectacular yield increases with N-fertilizer application in high-yielding varieties of rice resulted in depletion of large quantities of K from the soil. For example, a yield decline of 0.11 mt/ha for rice and 0.04 mt/ha for wheat was registered with time when currently recommended rates of NPK were applied in a long-term experiment conducted in the Punjab (Ludhiana). In this case, the depletion of soil K was mainly responsible for yield decrease because of a negative balance of -170 kg K<sub>2</sub>O/ha/yr. Actually, the annual K-balance in India is estimated as -37.5 kg K<sub>2</sub>O/ha of gross cropped area. Moreover, the balance of K worsens over time. According to soil fertility monitoring, both exchangeable and non-exchangeable K reserves are exhausted because of inadequate K-fertilizer application, raising serious concerns about soil fertility maintenance.

In a paper on “**Potassium fertilization in rice-rice and rice-wheat cropping systems in Bangladesh**”, **Dr. M.A.M. Miah (BRRI)** reported that in various experiments conducted in the Central and NW region of Bangladesh that K-fertilization significantly increased the production of rice-rice and rice-wheat cropping systems. In the control (native fertility) K plots of the long-term BRRI experiment (1985-2000), the yearly grain yield of rice decreased sharply with time from 10 to 6.2 mt/ha. Moreover, the yield gap between the balanced treatment and the control K treatment widened sharply with time. However, a severe depletion of soil K

was registered for both treatments: the balance of K in fertilized and omitted plots was -141 and -132 kg/ha/yr, respectively.

It has been also shown that K-fertilization at 50 kg K/ha appeared to be sufficient and economically most viable to produce optimum grain yield of rice in both dry and wet season on clay loam soil at Gazipur. In the NW region of Bangladesh, the rate of 66 kg K/ha was required for the highest yield of T-aman rice and wheat on sandy loam soil. Optimal fertilization with K increased rice grain yield by 16 per cent over the control K plot on clay loam soil, while yield increase due to K application on sandy loam soil was as high as 30 and 53 per cent for rice and wheat, respectively.

### Session III: Integrated nutrient management in horticultural crops

**D. N. Kumar (TNAU)** in a paper on “**Balanced fertilization for sustainable yield and quality in tropical fruit crops**” indicated that fruit production in India is hardly sufficient and meets only 46 per cent of national demand. Hence, there is a strong need to increase the production and productivity of fruit crops and judicious nutrient management is regarded as key to achieving these goals. The author presented TNAU fertilizer recommendation for mango, banana, citruses, papaya, pineapple and sapota. It has been noted that fruit plants generally need higher amount of K followed by N and P. The importance of K-fertilization for improving fruit weight, fruit number and fruit yield per plant was demonstrated in detail for papaya. K-fertilizer use improved also major quality parameters of papaya fruits such as sweetness, latex yield and its quality. The enzyme activity of latex, as assessed in terms of tyrosine units produced by papain, revealed the positive effect of potassium.

The results presented indicate that yield and quality parameters of fruit crops depend on the method of fertilizer application. When compared to conventional methods, fertigation proved to be the most efficient method of fertilizer application to fruit crops.

A paper on “**Integrated nutrient management for sustainable yield of major vegetable crops in Bangladesh**” was delivered by **Dr. M.S. Khan (BARI)**. He stressed that the production of vegetables in Bangladesh is inadequate and, to meet the growing demand, the production has to be increased by at least eight times (up to 11 million tons) by 2015. However, a gradual increase in cropping intensity with imbalanced fertilization depletes soil fertility in Bangladesh. Thus, BARI recommends the INM package formulated with mineral fertilizers (50-75 per cent from earlier recommendations developed for mineral fertilizers alone) and also organic manures. As a result, higher yields of tomato, cabbage, broccoli, okra as well as higher production of homestead vegetable cropping patterns (radish-tomato-red amaranth-Indian spinach, tomato-okra-Indian spinach) are obtained compared to the same levels of nutrients supplied in the form of mineral fertilizers alone. Compared to cow dung, poultry manure appeared as the best organic manure regarding yield sustainability and regeneration of soil fertility.

**Dr. S. Noor (BARI)** in her paper on “**Integrated nutrient management for sustainable yield of major spice crops in Bangladesh**” noted that spices are still falling behind demand with a yearly deficit of about 1.2 million tons. Because of shrinking land resources, the high demand in spice crops could be met only by increasing yield per hectare. The author reinforced that intensive crop cultivation with imbalanced fertilization resulted in severe

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degradation of soil fertility in Bangladesh. Research activities recently conducted by BARI indicate the need for including S, Zn and B into fertilizer packages for crops such as onion, garlic, chili, ginger, turmeric, coriander and black cumin. Updated recommendations for both mineral and organic fertilizers are based on crop response and economical profitability.

### Session IV: Balanced fertilization and environmental issues

**Mr. H. Magen (IPI)** in his presentation on “**Putting potassium in the picture: achieving improved nitrogen use efficiency**” stressed that potassium proves to be an efficient supplement for increasing the nitrogen use efficiency (NUE) over a wide range of crops, soils and agro-climatic conditions. The reporter assessed crop yield at a constant level of N application with increasing levels of applied potassium from a large number of field experiments conducted by IPI on various crops in Asia and Europe. A typical gain of 10 to 30 per cent increase in NUE was achieved by applying a moderate dose of potassium to maize, rice, wheat, rye and sunflower. When combining potassium application and advanced water management, gains can be much higher (like 70 per cent increase in NUE in fertigated sugarcane in India). Thus, applying potassium and improving nutrient management practices offer an immediate and rewarding strategy to raise NUE and thereby reduce the undesirable flow of nitrogen into the environment.

A presentation on “**Soil fertility history, present status and future scenario in Bangladesh**” was made by **Dr. M.S. Islam (BFA)**, who reviewed soil fertility research activities in Bangladesh since their initiation in 1905. It was stressed that Bangladesh has a wide variety and complexity of soils



Participants visiting the Bangladesh Rice Research Institute, Gazipur. Photo by V. Nosov.

which are depleted and there is urgent need for replenishment with organic and mineral fertilizers. The efficiency of fertilizer use is generally low because of imbalanced fertilizer application (under use or sometimes over use) resulting in huge wastages which the country cannot afford. Therefore, the practice of balanced fertilization should receive top priority to sustain/increase crop productivity. Food security is crucial for poverty stricken people, when the country is facing challenges of increasing population and shrinking natural resources which includes agricultural land. There is also a big gap between yields obtained in research and those found in farmers' fields. Promotion of balanced fertilization for different crops and cropping patterns at the various National Agricultural Research System institutes are passed on through the Department of Agricultural Extension and different NGOs and private companies. Field advisors should be trained properly in modern methods of soil fertility management. These advisors will in turn train the farmers who will adapt balanced fertilization practice in their farms to increase crop productivity. The

livelihood of farmers will thus be improved at the same time maintaining soil fertility for generations to come.

**Dr. M.F. Islam (SNV)** reported on major features of the Fertilizer Recommendation Guide (FRG) 2005 in a paper on “**Development of fertilizer recommendations in Bangladesh**”. It was again underlined that low fertilizer use efficiency at farm level necessitates the updating of current practices of fertilizer application to different crops grown in various environments. Since 1997, considerable progress has been made on soil fertility research by different national research institutes in the country. All these data have been collected and incorporated in the revised FRG 2005. Nevertheless, more research is needed on nutrient management in risk-prone ecosystems, multiple cropping systems, no-tillage/minimum tillage systems and hill farming. Furthermore, further research activities are required on developing fertilizer recommendations for improving both yield and quality of traditional fruit crops. More ecosystem based information on mineralization and

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nutrient release pattern of organic materials need to be generated for standardization of organic fertilizers.

A presentation on “**Role of micronutrients in balanced fertilization for sustainable crop production in Bangladesh**” was made by **Dr. M. Jahiruddin (BAU)**. As mentioned, until 1980, the farmers of Bangladesh applied three nutrients (NPK) to the soil and, thereafter, application of S and Zn was found necessary, particularly for rice cultivation. Maize and rice are the most sensitive crops to Zn-deficiency which particularly occurs in calcareous and submerged soils. Zn-fertilization is important in improving crop yield as well as nutritional (e.g. protein) and seed quality. In the 90s, B-deficiency of crops was also reported. It is much observed in Rabi crops, particularly mustard, wheat and chickpea and less reported in rice. There is sporadic information on Cu, Mo and Mn deficiencies in the country. Imbalanced use of mineral fertilizers, minimum application of organic manure, increasing cropping intensity, use of modern crop varieties, nutrient leaching, and the widespread occurrence of light textured soils favour the emergence of micronutrient deficiencies in soils of Bangladesh.

**Dr. S.M.I. Huq (UD)** presented a paper on “**Effect of balanced fertilization on arsenic and other heavy metals uptake in rice and other crops**”. It was apparent from the reported results that balanced fertilization in low land rice, though is necessary to keep the yield at optimum levels, cannot avoid the accumulation of As and other heavy metals in plants. On the other hand, upland crops like kangkong and amaranthus behave differently: balanced fertilization can improve the crop nutrient quality vis-à-vis As and other heavy metal accumulation in them. However, further research is required

for an in-depth investigation of these phenomena in fields.

### Field Programme

A field visit to BRRI was organized in-between two conference days. Dr. Md. Nur-E-Elahi, Director General of BRRI, informed delegates of the current research activities being carried out by the Institute. There was also a good opportunity to observe long-term fertilizer experiments conducted at BRRI.

### Read more about food production in Bangladesh

On 28 August 2008, FAO published a special report titled “FAO/WFP Crop and Food Supply Assessment Mission to Bangladesh”. Chapter 6.1 lists various recommendations, including advice on fertilization practices.

See the full report at <http://www.fao.org/docrep/011/ai472e/ai472e00.htm>.



The proceedings of the symposium were published in the **Bangladesh Journal of Agriculture and Environment, special edition**. To order a copy, contact the

Assistant Editor, Bangladesh Journal of Agriculture and Environment (BJAE), Bangladesh Fertilizer Association, City Heart Building (10<sup>th</sup> Floor), Room #8, 67 Naya Paltan, Dhaka-1000, Bangladesh. Phone/Fax: +88-02-9352410, 9348714 E-mail: [bfa\\_urbora@dhakacom.com](mailto:bfa_urbora@dhakacom.com) Website: <http://www.bfa-fertilizer.org/>

The special edition can also be downloaded at the [IPI website](http://www.fao.org/docrep/011/ai472e/ai472e00.htm).

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### Workshop Recommendations

The principal recommendations of the workshop may be summarized as follows:

- The lack of knowledge in balanced fertilization among the farmers is one of the main reasons for imbalance in nutrient application. The knowledge gap should be minimized through also the establishment of demonstration plots, and the distribution of information in communicable form including electronic media. Time, dose and cost effective methods of fertilizer application should be considered in these programs.
- The extension service providers should be trained with updated information on the importance of using balanced fertilization so that the information can be disseminated to the farmers as and when necessary.
- Emphasis should be given to include micronutrients in the balanced fertilization program. The application of organic fertilizers should also be stressed.
- Soil testing facilities should be developed at district level since this ensures proper application rates of fertilizers.
- A buffer stock of fertilizers should be maintained at regional and district level. The distribution system needs to be modified for quick availability of all fertilizers to the farmers at the right time to help them using balanced fertilization.
- The economics of mineral fertilizer use should be estimated taking into account input costs and values of agricultural production and the profitability of fertilizers needs to be regularly monitored.