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FERTILIZER DISTRIBUTION, SUBSIDY, MARKETING, PROMOTION AND AGRONOMIC USE EFFICIENCY SCENARIO IN BANGLADESH

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Fertilizer Distribution, Subsidy, Marketing, Promotion and Agronomic Use efficiency Scenario in Bangladesh

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Abstract

Bangladesh is the largest deltaic floodplain in the world with a total area of 147570 km^2 and population of 150 million people. Agriculture is the life force of her economy. The country has been a food deficit area for long time and has about 8.2 million hectares of cultivated land with average cropping intensity of about 185 per cent. Soil is the most important natural resource. The majority of the country's soils are alluvial. Hill and terrace soils represent only 20 per cent of the country and 8-10 per cent of the cultivable land. The principal crops grown include rice, wheat, maize, jute, sugarcane, winter and summer vegetables, tropical fruits, oilseeds, pulses, tuber crops, tobacco and tea.

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 in the form of siege. The UNO offices and dealers are targeted, and also road blockade takes place. Unfortunately, the law enforces choose violent methods to put an end to their legitimate demands. 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 peak 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 suphate 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 15% subsidy on imported TSP, DAP and MoP is given 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 (4.45 million tons). Timely supply of locally produced and imported fertilizers at the farm gates are handicapped by various constraints that result in crisis and dashes farmers' hope. 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 like 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 optimum level at any cost to face the challenges of growing more food in the country where food security is crucial for poverty stricken people, where about 2 million people are added to the total population every year and when the natural resources including agricultural land are shrinking.

Introduction

Bangladesh is the largest deltaic floodplain in the world with a total area of 147570 km^2 of which 88892 km^2 is occupied by major rivers and estuaries. The great delta is flat throughout and stretches from near the foothills of the Himalayas Mountain in the north to a southern irregular deltaic coastline that faces the Bay of Bengal. The country is mostly surrounded by India except for a short (about 200 km) southeastern frontier with Burma. She lies between $20^0 34''$ and $26^o 38''$ north latitude, and $88^o 01''$ and $92^o 41''$ longitude.
Bangladesh is one of the densely populated countries in the world with about 150 million people. The population density is around 974 people per km^2 with annual growth rate of 1.54 percent. Agriculture is the life force of her economy. The country has been a food deficit area for long time and has about 8.2 million hectares of cultivated land with average cropping intensity of about 185 per cent (BBS 2005). Soil is the most important natural resource. The majority of the country's soils are alluvial. Hill and terrace soils represent only 20 per cent of the country and 8-10 per cent of the cultivable land. Agro ecologically the country has been divided into thirty regions. The principal crops grown include rice, wheat, maize, jute, sugarcane, winter and summer vegetables, tropical fruits, oilseeds, pulses, tuber crops, tobacco and tea.

Soil fertility has been engaging the attention of soil scientists and agronomists of the country since late fifties. Till the introduction of fertilizer responsive high yielding varieties in sixties, it was mostly subsistence agriculture with very low yields without showing any stress on soil fertility. The data from agricultural research station before 1965 hardly showed any significant response to added P and K. Even with N, the responses were not significant. After the introduction of high yielding varieties and launching intensive cropping for maximum crop production per unit area and per unit time, rapid depletion of soil fertility has been observed almost all over the country. The most widely deficient nutrients in the soils are nitrogen, phosphorus, potassium and sulphur. Zinc deficiency is prevalent in calcareous soils and light textured soils where cropping intensity has been increased. Boron deficiency is also being observed in many areas and may be considered as one of the responses for causing sterility in wheat, sunflower, mustard and deformed fruits in papaya. Magnesium is being observed deficient in Old Himalayan Piedmont Plain soils and Acid Brown Hill soils.

Bangladesh Background

Bangladesh is mainly a land of largest deltaic plain in the world lying in the northeastern part of South Asia. The great delta is flat throughout and stretches from near the foothills of the Himalayas Mountain in the north to the Bay of Bengal in the south. She is mostly surrounded by India except for a short (about 200 km) southeastern frontier with Burma and a southern irregular deltaic coastline that faces the Bay of Bengal. She lies between $20^o 34'$ and $26^o 38'$ north latitude, and $88^o 01'$ and $92^o 41'$ longitude.

The area of the country is 147570 km^2 of which 88892 km^2 are occupied by major rivers and estuaries. Bangladesh is an agricultural country and physiographically can be divided into northern and eastern hills, terrace areas and floodplains representing 12, 8 and 80% of the land resources. Agro ecologically the country has been divided into thirty regions. The principal crops include rice, wheat, maize, jute, sugarcane, winter & summer vegetables, tropical, fruits, oilseeds, pulses, tuber crops, tobacco and tea.

The total forest area covers about 13.36% of the total land area. The country produces timber, bamboo and cane. Plantation of rubber in the hilly regions of the country was undertaken recently and extraction of rubber had already started.

Bangladesh enjoys subtropical monsoon climate. Monsoon generally starts in June and continues up to October in which 80% rainfall occurs. The average rainfall varies from 1429 to 4338 mm. Coastal areas of Chittagong and northern part of Sylhet receives the highest rainfall. About one third of the country especially low-lying areas are subject to severe flooding from monsoon rains, cyclones, and storm, which bring major crop damage and high loss of life almost every year. Storms and cycles generally occur in the months of April-May and October-November when the monsoon wind changes its direction. The temperature varies from minimum of 04^oC in winter to a maximum of 40^oC in summer.

Bangladesh is one of the densely populated countries in the world with about 150 million people. The population density is around 974 people per km^2 with annual growth rate of 1.54 percent. The number of households is estimated to be 28 million and member per family is reported to be 5.18. About 89.7 percent of the population is Sunni Muslim and the rest 10.3 percent is Hindu, Buddhist and other ethnic groups. Over 80 percent population of Bangladesh resides in rural areas.

The economy of Bangladesh is based on agriculture. Fishing is also an important economic activity. Exporting of garments products is one of the largest sources of national income. Remittances from several million Bangladeshi working abroad are also an important source of income. Economic performance has been relatively strong in the past decade; with GDP growth averaging 5.38 and agricultural growth rate around 3.29 percent. The country has made considerable progress in reducing poverty in comparison of 1980s when nearly one third of the population was at that time. However, agricultural laborers and farmers fall under the high level of poverty. The average per capita income is about Tk 28830.00 equivalent to US$ 470.00

Role of Agriculture in Bangladesh Economy

Agriculture is the life force of Bangladesh economy. It plays a vital role in socioeconomic progress and sustainable development through upliftment of rural economy, ensuring food security by attaining autarky in food grain production, alleviation of poverty and so on. Bangladesh as a whole has been food deficit area for a long time.
During 2004-05, the combined contribution of all sub-sectors of agriculture (crop, livestock, forestry and fisheries) to GDP was 21.91 percent (Bangladesh Economic Review 2005). The crop sub-sector was projected to contribute 12.10 percent and fisheries sub-sector accounted for 5.03 percent. The agriculture sector is the single largest contributor to income and employment generation and an element in the country’s challenge to achieve self-sufficiency in food production reduce rural poverty and foster sustainable economic development. The government has, therefore, accorded highest priority to this sector to enable the country to meet these challenges and to make this sector commercially profitable. Of the total labour force in Bangladesh, 51.7 percent are engaged in agriculture. The contribution of agricultural products including raw jute, jute goods and tea to the total exports of the country is 5.79 percent. In terms of value addition, the contribution of to the national economy is immense.

Land Resources

The total land area is estimated to be about 14.84 million hectares (ha) of which 8.29 million ha are used for agriculture; 2.40 million ha are forest (including community forest and village forest), 2.31 million ha are under settlements (urban and village), 0.32 million ha as fellow but cultivable, 0.41million ha fellow, 0.16 million ha wasteland and the remaining 0.95 million ha are regarded as some miscellaneous land such as graveyards, eidgahs, market etc.
The per capita agricultural land that would support the basic needs of the population is fast decreasing. In 1951 when the total population was about 47 million the per capita agricultural land was 0.16 ha. In 1981 when the population increased to 88 million the per capita agricultural land decreased to 0.10 ha. At present, when the total population is estimated to be 145 million the per capita agricultural land is about 0.066 ha.

There is limited scope for bringing new land under cultivation. Above all, every year a good portion of agricultural land is being degraded. On ecological aspects, Bangladesh is passing a phase of ecological deterioration leading to loss of plant cover thus lowering organic matter content of the soil, reduction in varietal diversity, lowering water-holding and fertility of the soils, lowering ground water table, loss of wetlands, and many others. The process of ecological deterioration is negatively affecting the already fragile livelihood of the rural poor, lack of fuel and fodder, lowering land productivity level and lack of access to common property such as community jungles, grazing lands, use of ponds, etc. Thus, it is quite evident that the precarious land-man ratio has made agricultural land most precious resource and, therefore, due attention should be given for its optimum utilization.

Population Projections Up to 2025

Bangladesh is the densely populated country in the world having present population of 145 millions with present growth rate at 1.54 percent. According to World Bank's estimates and projections, the population in Bangladesh will continue to increase in coming years (Table 1). It is estimated the population of Bangladesh during 2005, 2010, 2015, 2020, 2025 and 2030 will be around 143, 153, 163, 172, 182 and 191 millions, respectively. Therefore, food security for a large number of people would be a challenge to the government for coming years. All technologies related to higher crop production need to be transferred among the farmers with strong backup supports.

Table 1. Estimates and projections of Bangladesh's population and relevant demographic parameters (BBS 2005).

Year	Population (millions)	Change of parameters between each 5-year period						
		CBR	CDR	TER	e (0)	IMR	NRR	Growth rate (%)
1990	109.82	31.4	11.2	4.00	55.5	91	1.57	1.96
1995	121.11	28.3	9.9	3.39	57.6	78	1.38	1.79
2000	132.42	25.2	8.9	2.87	59.9	65	1.21	1.59
2005	143.38	22.0	8.1	2.44	62.2	54	1.06	1.36
2010	153.44	20.5	7.9	2.88	63.4	49	1.00	1.23
2015	163.16	19.7	7.9	2.26	64.6	45	1.00	1.16
2020	172.90	18.7	8.0	2.24	65.8	40	1.00	1.06
2025	182.31	17.6	8.1	2.21	67.1	36	1.00	0.94

CBR-Crude Birth Rate (per '000'), CDR-Crude Death Rate (per '000'), TER-Total Fertility Rate (no of birth per woman), e (0)-Life expectancy at birth (years), IMR-Infant Mortality Rate (per '000'live births), NRR-Net Reproduction Rate.

Fertilizer Use in Bangladesh

The use of chemical fertilizers in Bangladesh agriculture started with import of 2698 tons of ammonium sulphate. 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 demand sharply increased with the introduction of high yielding rice varieties. After the liberation war, significant consumption of fertilizer was noted during 1975-76. Since then increasing trend of fertilizer was being observed which reached peak value of 40.05 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 2. Consumption of different fertilizers in Bangladesh during the last forty years (Mt).

YEARS	UREA	TSP	SSP	DAP	MOP	GYPSUM	ZINC SULPHATE	AS	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	2515000	340000	122000	115000	230000	72000	26000	25000	120000	3565000
2007-08	2400000	300000	120000	100000	200000	65000	25000	24000	100000	3334000

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 fertilizer 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 door steps of the farmers. The dealers lifted fertilizers from the BADC Thana godown 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 godown.

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 unnecessary 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; 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 godown, 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 also monitored the prices of the fertilizers along these reforms.

The last reform under FDI-I was to withdraw price control over sale of fertilizer at the farmers' level. This system was introduced in the Chittagong division first and then gradually whole 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 to1987 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 BADC and private companies/dealers both imported fertilizers from abroad. Later on, because of high competition with the private companies and high prices of BADC imported fertilizers (Table 2), the latter was instructed by the government to shut down all fertilizer business activities. This is how the privatization of fertilizer distribution and took place in the country.

Table 3. Prices of fertilizers imported by BADC and private companies during 1991-92.

Name of fertilizer		Import(Mt)	C & F Price (US$)	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
	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 severe shortfall:

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, after threadbare discussion, 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 six 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 BCIC's 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.

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 such high price hike, the balanced use of fertilizer was being seriously affected. The Bangladesh Fertilizer Association proposed to the government about the introduction of subsidy on these fertilizers so that the farmers could use balanced fertilizer 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 4. Comparative prices (Tk) of 50 kg TSP, DAP and MoP bag during 2004-06.

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

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.

First step: Whenever the vessel carrying fertilizer of an importer reaches to the outrage of Chittagong port, he then submits all documents to the cell at the office of the Additional Director, DAE. This cell examines all the documents and then sends samples to the designated laboratories for testing. After testing, the cell sends the report to the Ministry of Agriculture. At the Ministry's directives the storage enquiry subcommittee inspects the godown where the fertilizer of the importer is stored. After inspection this subcommittee sends report to the price fixation subcommittee which then again examines all the documents of importer and fixes price of the fertilizer according to guidelines and then forwards the report to the price fixation & monitoring committee.

Price fixation and monitoring committee examines the recommendations of storage enquiry subcommittee and price fixation subcommittee, reviews the international prices and carrying and freight cost, considers other miscellaneous cost and then fixes the price of imported fertilizer by adding US$ 29.84 to each ton. The committee prepares recommendation report, after deducting 25% of the total price and submits it to the steering committee for approval. In the report conditions are imposed in such a way that the importer will get back his deducted money (25%) after selling the fertilizer within 4 months as soon as he gets clearance from the Ministry. After approval of the steering committee, the sale order is issued to the importer with carbon copy to the respective Deputy Commissioner (DC) so that the latter knows how much fertilizer is coming to his district. If the storage gowdown is not in Chittagong and located at Nayaranganj, Naopara (Jessore) or Baghabari (Sirajganj), than additional 1.5 US$ is added to per ton of fertilizer.

Second step: After getting clearance, the fertilizer dealers can lift fertilizer from the 4 assigned godowns to their own godowns with three receipts. Out of three receipts, the dealer keeps one with him, another with DC office and the third copy is signed by the Upazila Nirbahi Officer who ensures arrival of fertilizer in the dealer's gowdown after physical verification. The signed copy is then forwarded to Deputy Commissioner who is the chairman of the district fertilizer and seed monitoring committee for signing. The committee adds transport as well as other miscellaneous costs to the fertilizers and then fixes the price at which the dealers will sell to the farmers. The sale of the fertilizer among the farmers is monitored by the committee.

Third step: The Deputy Commissioner, after signing the copy, sends it to the importer with carbon copy to the Ministry of Agriculture. The Ministry verifies and crosschecks DC's and importer's copies and then forwards it to the Ministry of Finance for approval. After getting approval from the Ministry of Finance, the Ministry of Agriculture makes payment of deducted 25% to the importer.

Changes in Subsidy

From the above subsidy payment method, one can easily understand how complicated is the process of obtaining subsidy money from the government. 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 government has reduced the subsidy of imported TSP, DAP and MoP from 25 to 15% since July 2007.

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 fertilizer 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 has become 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 the cost of 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 3 shows the total proposed scenario during 2008-09.

It is quite evident that there will be shortfall of 13.50 lakh tons of urea which the government will meet through import and local purchase from Karnafuli Fertilizer Company (KAFCO). TSP and DAP amounting to 4.50 and 1.00 lakh tons will be imported by the private companies. BADC will import only 0.50 tons of TSP. Private Companies will import 3.50 lakh tons and BADC 0.50 lakh tons of MoP to meet potash requirement. Most of the secondary and micronutrient fertilizers are made in the country by the private companies.

Table 5. Proposed 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 $/MT)
				Factory	Buffer	
Urea	28.50	15.00 from 6 Urea Factories	13.50 (4.5 from KAFCO)	10,000.00	10,700.00	115 (Production) 500 (Import) 450$ 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)
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			

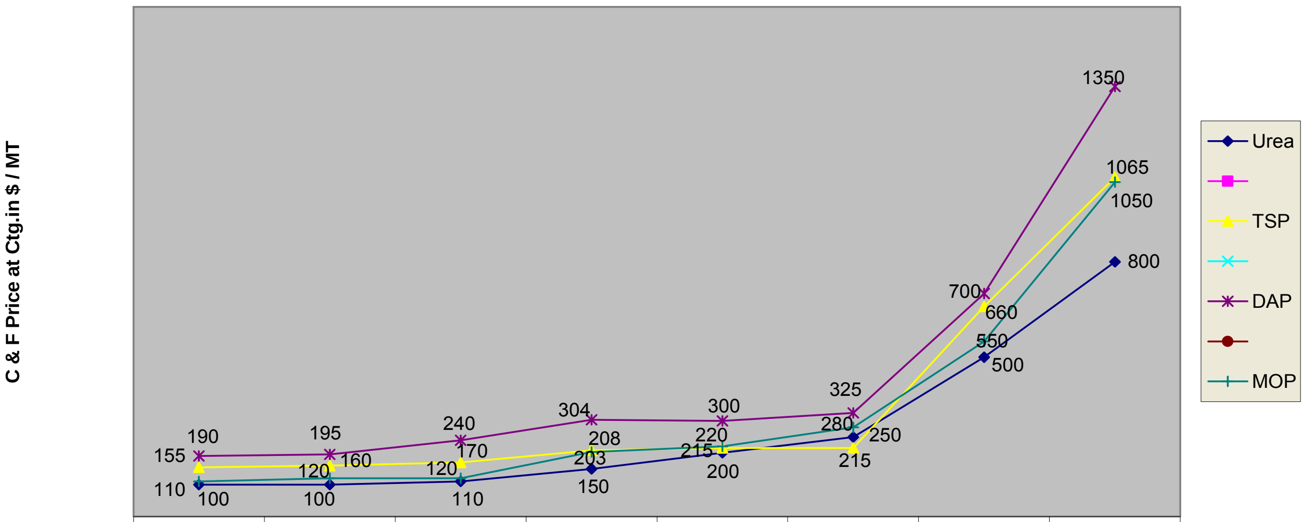
Total demand: 44.45 lakh MT

Price Hike: Tables 4 and Fig. 1 show that the prices of the fertilizers have gone up sharply in the international markets during the last 3-4 years because of high energy costs and shrinkage of fertilizer production materials. Because of high prices and crisis of the fertilizers, there will be negative effect of crop production. Some headlines published in daily star may be quoted like these:

Pricy fertilizers make Aman prospect bleak in Rangpur; increased diesel, fertilizer prices- Aman farming to cost Tk 965 crores more in north; and fertilizer crisis dashes hopes for better tea yield.

Figure 1. Cost of urea, TSP, DAP and MoP in the international markets during 2001-08.

Trend of International Price of Urea,TSP, DAP & MOP Fertilizer in Last 8 years



	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

Table 6. Comparative prices of fertilizers during 2007-08 and 2008-09.

Name of Fertilizer	**Market Price of Fertilizer**	
	2007- 2008 (Tk/Ton)	**2008-2009 (Tk/Ton)**
Urea	6000	12000
TSP	30,000	65,000
DAP	36,000	99,000
MOP	28,000	43,000
AS-Imported	20,000	22,000
AS- BCIC		35,000
$MgSO_4$	30,000 (IP105$)	40,000
$ZnSO_4$ (Hepta)	35,000	70,000
$ZnSO_4$ (Mono)	55000	95,000
Boric acid (Brazil)	60,000	1,00000
Chelated Zn (Spain)	-	4,50,000
Sulphur-90 (Canada)	40,000	70,000

Proposed change in marketing system

Because of the different complaints being heard and seen through electronic media such as TV and BBC dialogue on Bangladesh as well as printed 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 pilot scale in some selected upazilas. On the basis of successful observations, the free marketing of fertilizers may be expanded all over the country.

Domestic Production

In Bangladesh urea, TSP and SSP are produced in the local industries, which can partly meet the total demand of the country (Table 5). About 60000 phosphogypsum is produced as a byproduct from TSP factory. At present there are six urea and one TSP factories in the country. Natural gas provides the feedstock for urea production. Bangladesh Chemical Industries Corporation (BCIC) is responsible for operation of all fertilizer factories in the country. All these fertilizer 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 are met up from import. Additional requirements of TSP, DAP and gypsum are also imported. All MoP are imported.

Timely supply of locally produced and imported fertilizers at the farm gates are handicapped by various constraints that result in crisis and dashes farmers' hope. 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. 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.

Table 7. Domestic Fertilizer Production during last ten years (1994-95 to 2005-06).

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 (Proposed)	1700000	50000	100000	100000

There are more than 50 small zinc sulphate manufacturing factories in the country. These are mostly concentrated around Jessore-a southwestern district. These factories can 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. At present as many as10 companies are producing NPKS mixed fertilizers. Among the companies, 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 among 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 to grow more food, 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. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and are in urgent need of replenishment with organic manure and fertilizers if projected crop production target is to be obtained.

Nitrogen

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

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

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:

- Low: up to 0.090-0.181 %
- Medium: 0.181-0.270%
- Optimum: 0.271-0.360%

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 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 $\mu g\ g^{-1}$ soil is interpreted as low, 15.1-22.5 $\mu g\ g^{-1}$ soil as medium and 22.51-30.0 $\mu g\ g^{-1}$ 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 $\mu g\ g^{-1}$soil are considered as low, 12.1-18.0 $\mu g\ g^{-1}$ soil as medium and 18.0-24.0 $\mu g\ g^{-1}$ soil as optimum. The critical level of P by the Olsen method, which is extensively used for rice, has been considered as 8.0 $\mu g\ g^{-1}$soil in Bangladesh so long.

Appreciable response of wetland rice to P fertilization is rarely observed in Bangladesh soils. On the other hand, P 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 comparatively rich in potash bearing minerals than 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 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. Since then sulphur deficiency in Bangladesh soils is becoming widespread and acute. Variable amount of available S ranging from as low as 2 $\mu g\ g^{-1}$ soil to as high as 75 $\mu g\ g^{-1}$ 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, black gram 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. 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 $^{-1}$. 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, thus correcting Ca deficiency properly.

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 improved by the application of boron. The wheat yield after boron treatment was increased by more than 50% and was contributed by increased number of grain 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 agriculture. Generally 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 and legumes like groundnut 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 betel nut 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 Bangladesh soils.

Fertilizer Recommendation

Fertilizer recommendation for single crops and cropping patterns are usually made by following the guidelines clearly stated in “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 engaged 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 guide 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 is not available, moderate yield target may be fixed and the information available about agro ecological region in the guide may be used to find out the fertilizer doses.

Research on site-specific N management using leaf color chart in Bangladesh is in progress at the Bangladesh Rice Research Institute.

Balanced Fertilization

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 t grain yield) is shown below:

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

In view of the continuous nutrient depleting situations, the adoption of IPNS which is a modern system of nutrient management, can only provide ideal nutrition for a single crop/crops grown in a pattern. The major objectives of IPNS may be conceptualized as follows:

- 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 manuring 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 for Promoting Balanced Fertilization

Extension activities on balanced fertilization have been undertaken by various research institutes, GO/NGOs and development partners through out the country. Technologies generated on balanced fertilization practices for different crops and cropping patterns at the various National agricultural Research System (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 through which they are trained about the beneficial aspects of the technology. For example, BRRI arranges training program on rice production technology in which various aspects of soil fertility management are covered. BARI organizes similar programs on 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 fertilizer use technology is the key issues. BARI OFRD 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.

BARC's Technology Transfer and Monitoring Unit (TTMU) also serve 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 donor projects such IFAD SAIP, ADB NW Crop Diversification and FAO/UNDP project on food security in DAE are also making significant contribution to agricultural development in the country.

Agronomic Use Efficiency

Use Efficiency of Nitrogenous Fertilizers

Nitrogen is the most limiting plant nutrient in Bangladesh 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, may contribute to global warming and never reaches to the plant 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, denitirfiacation, runoff, seepage and leaching.

Nitrogen losses through nitrate leaching can be substantial in sandy soils in drier regions. While $N0_3$ 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 should not contain more than 50 μgml^{-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 μgml$^{-1.}$ 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 also 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 yield increase from applied N.

USG application for rice: Application of urea super granules 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.

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 is feasible for use by the marginal and resource-poor farmers.

Use Efficiency of PKSMg Fertilizers

Among the phosphate, potash, sulphur and magnesium 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 which leads to excessive growth of algae) is the main reason for concern related to P losses. Phosphorus is mainly lost by surface runoff. The total lost includes P dissolved in runoff water and P adsorbed to eroded particles. Hence, heavy rainfall shortly after surface application of mineral 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's 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 insufficiency. 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 as well correct Mg deficiency. The use efficiency of magnesium fertilizers is satisfactory.

Use Efficiency of Micronutrient Fertilizers

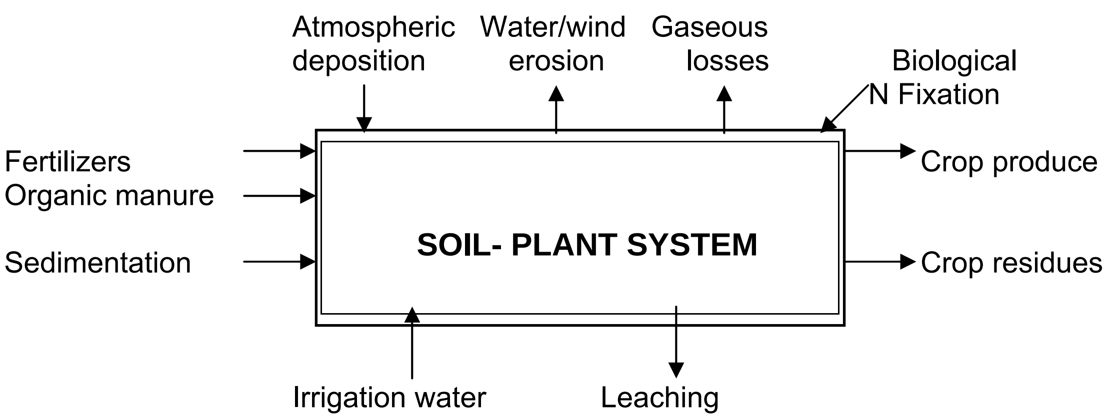
Among the micronutrients, Zn and B deficiencies occur in calcareous and light textured soils where cropping intensity is high. The application of zinc and boron fertilizers is useful and effective in deficient soils. The addition of these micronutrient fertilizers leaves lots of residual effects in soils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

Use Efficiency of 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.

Conclusions and Recommendations

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 successful 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 manure and chemical fertilizers.



At present more than 4.45 million tons of chemical fertilizers pricing to more than US $ 10,000 millions are being used along with 70 million tons of organic manure. The use efficiency of the chemical fertilizers are low and unsatisfactory because of imbalanced or under use/sometimes over use resulting in huge wastage which the country cannot afford. Therefore, the practice of balanced fertilization should receive top priority to sustain/increase crop productivity when food security is so crucial for poverty stricken people, when the country is facing challenges of increasing population and shrinking natural resources including agricultural land and also when there exists big gap between research and farmer's yield.

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