Use of Bioslurry as Organic Fertilizer in Bangladesh Agriculture

By

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Abstract

Bioslurry may be considered as a good quality organic fertilizer in Bangladesh agriculture. Analysis of representative cow dung and poultry litter slurry samples from biogas plants made at the Bangladesh Agricultural Research Institute (BARI) and Dhaka University (DU) has shown that slurry contains a considerable amount of both macro and micro nutrients besides appreciable quantities of organic matter. Toxic heavy metal concentration in them is minimal.

More than 25,000 biogas plants of varying gas-producing capacities (2-6 m^3) run with cow dung and poultry litter for domestic purposes and some large sized ones in poultry farms are in operation in the country. These biogas plants generate more than 200,000 tons of slurry on dry weight basis which is equivalent to about 9,000 tons of urea + 25,000 tons of triple super phosphate (TSP) + 3200 tons of muriate of potash (MOP) plus other secondary and micronutrients. Unfortunately, slurry handling at the plant premises is highly unsatisfactory. No proper methodology is followed. As a result, the loss of nutrients from slurry collection point is substantial.

Due to changing scenario of soil fertility management through **Integrated Plant Nutrition System (IPNS)** that combines the use of organic and chemical fertilizers, the bioslurry organic fertilizers play a vital role in restoring fertility as well as organic matter status of the soils. Organic matter content in Bangladesh soils is alarmingly low around 1% in most and 2% in few soils, whereas it should be maintained at least 3% that is conducive to high crop productivity.

Bioslurry organic fertilizer is environmental friendly, has no toxic or harmful effects and can easily reduce the use of chemical fertilizers up to 50%. Nutrients from organic sources are more efficient than those from chemical sources. **Bioslurry is a 100% organic fertilizer** most suitable for organic farming for some high value field and horticultural crops.

Field trials conducted by Grameen Shakti and others have shown beneficial effects of bioslurry organic fertilizers in increasing the yields of cabbage, brinjal, tomato, onion, potato and papaya. Poultry manure along with urea super granule also increased the grain yield of rice when compared with ordinary prilled urea. Trials on cabbage using cow dung, poultry manure and mustard oil cakes have indicated that mustard oil cake (2.5t/ha) and poultry manure (10t/ha) along with chemical fertilizers could increase higher gross margin in Grey Terrace soils of Gazipur.

The farmers of Bangladesh hardly follow any scientific method to produce organic fertilizers. According to expertise's estimate, about 7.0 million tons of organic fertilizers are produced every year from animal wastes, household wastes, city wastes and crop wastes. The farmers usually dispose the animal wastes mainly dung in the open pit and leave there at least three months before they use them for their crop fields. However, some private companies have come forward to produce and market organic fertilizers. Grameen Shakti has made an agreement with two companies to market bioslurry organic fertilizers from its constructed biogas plants under the brand name **Grameen Shakti Jaibo Sar**. **SNV-IDCOL** has started implementing a national

program where use of both biogas for household cooking and bioslurry as organic fertilizer are being promoted.

The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and decline in crop yields is observed everywhere if proper fertility management is not made. The farmers use mostly chemical fertilizers indiscriminately without adequate information on actual soil/plant requirement. This results in over application of some nutrients, under application of others and general inefficiency of the costly fertilizer input. Nitrogen, phosphorus and potassium deficiencies are observed everywhere in the country. Except coastal and acid basin clays sulphur deficiency is prevalent all over the country. Magnesium deficiency is being noticed in all acidic soils particularly in acid brown hill soils, old Himalayan piedmont plain soils and also in some terrace soils. Zinc deficiency mainly occurs in calcareous soils and also in areas where cropping intensity has been increased. Boron deficiency is seen in light textured soils and is more evident on cruciferous crops.

The use of chemical fertilizers began in the country in early sixties. Fertilizer demand sharply increased with the introduction of high yielding rice varieties. After the liberation war, significant consumption of fertilizer was being observed which reached peak value of about 4 million tons during 2005-06. Along with urea, phosphate and potash - the use of gypsum, zinc sulphate, and other micronutrients have also been increased. In Bangladesh urea, triple super phosphate (TSP) and single super phosphate (SSP) are produced in the local industries, which can partly meet the total demand of the country. Additional requirements of urea, TSP and gypsum are met from import. All muriate of potash (MOP) and diammonium phosphate (DAP) are imported.

To reduce poverty and malnutrition as well as to attain and sustain self-sufficiency in food and fibre crops within shortest possible times, intensification of agricultural production by multiple cropping, increasing cropping intensity and the use of high yielding varieties is a must. Such challenging activities that are very much needed for food security throughout the country involve a complete management package that depends heavily on plant nutrient supply and balance. Under such situations, mineral fertilizers alone cannot correct all the deficient nutrients in the soils. Due to high oil prices in the international market and shrinking of natural resources, the prices of imported fertilizers will continue to increase in the coming years. Therefore, mobilization of all native organic sources and recycling them into soil fertilization program should get topmost priority. Biogas technology is one such program that should be promoted with all out efforts. This technology not only provides energy for multiple uses, but also good quality bioslurry that can be used as organic fertilizer.

With the organic resources available every day, it is possible to construct **4 million biogas plants in the country**. From these biogas plants a huge quantity of organic fertilizer will be available to supplement chemical fertilizers for land application. The Government has been subsidizing heavily urea fertilizers since long and introduced 25% subsidy on imported TSP, DAP and MOP fertilizers. Therefore, to harness immense potential opportunities of biogas technology, the Government should come forward and provide at least **40-50% subsidy to biogas program** and thus encourage private companies/NGOs in promoting this technology for **solving growing fuel crisis in rural households** as well as **fertilizer crisis in Bangladesh agriculture**.

Introduction

Bioslurry is an anaerobic digested organic material released as byproduct from the biogas plant after production of combustible methane gas for cooking, lighting and running machinery. The organic materials generally used in Bangladesh as raw materials for biogas plant are cow dung, poultry litter and other easily decomposable materials such as kitchen refuses, farm wastes, water hyacinth, and crop residues. Night soils or human excreta are also used for producing biogas, although there is some social reservation to utilize them. The biogas plant owners still hesitate to handle the bioslurry. Attaching latrine to biogas plant has dual benefits: the disposal problem of human excreta which is hazardous to health is solved thereby improving environment and sanitation, and additional amount of gas as well as manure is produced as a result of using latrine wastes in conjunction with cow dung or poultry litter. Anaerobic fermentation or decomposition is usually brought about by a special group of microorganisms called methanogenic bacteria. Biogas produced in the digester principally consists of 60-70% methane, 30% carbon dioxide and traces of different hydrocarbons, nitrogen, hydrogen sulphide etc.

Bioslurry obtained from the biogas plant may be considered as a good source of organic fertilizer as it contains considerable amounts of both macro and micronutrients (Table 1). Raw bioslurry can be used as fish feed in ponds or lakes and also be used to fertilize aquatic plants, which are ultimately eaten by the fishes. Bioslurry contains appreciable amounts of organic matter (20 to 30%) very much needed for our hungry soils. Bioslurry is alkaline in reaction and has liming effects. It is very useful for reducing harmful effects of aluminum in acid soils. Thus, it can be easily seen that the use of bioslurry has multiple benefits.

Importance of Bioslurry

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 is going on. 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.

Bangladesh is an agricultural country and her soil is the most important natural resource. Unfortunately, organic matter content in most of the Bangladesh soils is alarmingly low. It is generally around 1% in most and around 2% in few soils. In some soils organic matter content is even lower than 0.50%. This is due to intensification of agriculture to grow more food for the teeming millions and indiscriminate as well imbalanced use of chemical fertilizers with little or no addition of organic fertilizers. As a result, the fertility of the country's soils has been declining day by day. Due to continuous mining of nutrients, many soils are loosing their productive capacity. To make the soils productive the organic matter content in them should be maintained at least at 3% level.

Under such situations, to sustain crop productivity and to increase fertility, there is no alternative but to add organic fertilizer in the soils. Bioslurry could be one of the best organic fertilizers to rejuvenate soils since it is a rich source of both plant nutrients and organic matter. The agricultural scientists most often call organic matter as the **Life of the soils** and also term it as the **storehouse of the plant nutrients**. Bioslurry when

properly processed and applied can increase the physical, chemical and biological properties of the soils besides supplying essential nutrients to the crop plants. It increases the organic matter content of the soils and thus the health of the soils is maintained. The use of bioslurry can reduce the application of chemical fertilizers to a great extent. It is possible to reduce the use of the chemical fertilizers up to 50%. As a result, using reduced doses of chemical fertilizers will benefit the farmers in their cultivation costs and the soil environment will be in a high fertility and productive state.

Table 1. Nutrient and heavy metal content as well as other characteristics of bioslurry of biogas plants.

Nutrient content	Cow dung slurry		Poultry litter slurry	
	BARI values	DU values	BARI values	DU values
	%			
Total Nitrogen	1.35	1.23	2.71	2.75
Total Phosphorus	2.89	2.71	3.35	3.24
Total Potassium	0.88	0.62	0.85	0.75
Total Sulphur	0.71	0.67	1.00	0.91
Total Calcium	0.92	0.80	4.50	3.90
Total Magnesium	0.62	0.72	2.60	2.42
Total Iron	0.103	0.800	0.209	0.198
Total Manganese	0.080	0.090	0.067	0.071
Total Boron	0.069	0.060	0.041	0.050
	$\mu g\ g^{-1}$			
Total Zinc	610	580	717	590
Total Copper	428	450	224	260
Heavy metal				
Total Arsenic	1.47	1.40	1.77	1.32
Total Lead	11.37	12.00	20.09	21.00
Total Cadmium	3.64	4.35	4.28	3.90
Other characteristics				
Moisture (%)	11.25	12.00	11.17	11.79
pH	7.94	8.21	8.31	8.35
Organic matter (%)	26.04	27.78	21.58	30.34
Colour	Brownish		Grayish	
Physical conditions	Powder, free flowing		Powder, free flowing	

Present Biogas and Manure Program

At present about 16 governments and nongovernmental organizations are involved in disseminating biogas technology to the rural households of Bangladesh. None of the organizations except Grameen Shakti (GS) has manure program. By the time GS has successfully completed a pilot project and completed construction of than more than 350 biogas plants. GS plans to construct around 3000 biogas plants by the end of 2006. GS

has also undertaken an ambitious program of constructing 200,000 biogas plants within 2010. GS has standardized different sizes of the plants with their expenditure to promote the biogas program throughout the country. GS program follows **no profit no loss approach**, providing soft loans to the small farmers to make biogas plants more affordable.

Grameen Shakti has recently signed a Memorandum of Understanding with the Ministry of Environment and Forest to implement a project on generation of biogas from water hyacinth and poultry litter. Three biogas plants have already been constructed at Gazipur where poultry litter is being used as raw material. Another two biogas plants have started functioning at Jessore where water hyacinth and cow dung are being used as raw material. The study on the efficiency of these raw materials for producing biogas is underway.

For marketing of slurry commercially, GS has undertaken SME development program throughout the country. Two private companies namely- MATI at Gazipur and Faridpur Muslim Mission have already signed MoU with GS and started marketing bioslurry organic fertilizers under the brand name **Grameen Shakti Jaibo Sar.**

SNV- IDCOL Program

Under the funding of the Netherlands Development Organization (SNV), Infrastructure Development Company (IDCOL) has started implementing a project entitled **National Domestic Biogas and Manure Program (NDBMP)** in Bangladesh since January 2006. The overall objective of the program is to further develop and disseminate domestic biogas plants in rural areas with ultimate goal to establish a sustainable and commercial biogas sector in Bangladesh. The project activity will continue up to December 2010. Under the program, as many as 60,000 domestic size biogas plants will be constructed. The use of bioslurry generated from these plants will be promoted and popularized among the biogas owners and farmers for land application.

Present Status of Slurry Handling

More than 25,000 biogas plants of varying gas-producing capacities (2 -6 m^3) run with cow dung and or poultry litter for domestic purposes and some large sized ones in poultry farms are now in operation in the country. These biogas plants generate more than 200,000 tons of bioslurry on dry weight basis. This bioslurry is equivalent to about 9,000 tons of urea + 25,000 TSP + 3,200 MOP plus other secondary and micronutrients. It is reported that some owners of the biogas plants use bioslurry for their homestead gardening, while others use them as fish feed in ponds. Full utilization of bioslurry as good quality organic has yet to be realized among the plant owners and farmers.

Present bioslurry handling at the plant premises is highly unsatisfactory. It appears that the biogas plant engineers have not so long given any emphasis on bioslurry as feed, fertilizer and soil amending material. None of the biogas plants have the proper system of bioslurry collection, drying, processing and bagging. Bioslurry coming from the hydraulic chamber or outlet of plants is just allowed to drain out freely in the open spaces. Sometimes it is allowed to go into the ditches nearby. Most of the engineers and plant owners have the idea that if the liquid portion of the bioslurry leaches down, then it will be quicker for sun drying. But the loss of soluble nutrients along with liquid has not been realized. In fact, there should be well-built bioslurry pit just by the site of hydraulic

chamber so that bioslurry can easily be collected or fall into the pit. It is advisable to have a roof over the collecting pit so that no rainwater can fall over the bioslurry. For sun drying there should be a drying bed nearby. During rainy season there should be provision for indoor drying or low cost sun dryer may be used. After sun drying the bioslurry may be directly used in the crop fields. For commercial marketing, bioslurry should be properly dried, sieved and stored in gunny or polypropylene 50-, 25-, 5- and 1-kg bags.

Utilization of Bioslurry

Bioslurry obtained from biogas plant may be considered as quality organic fertilizer. This organic fertilizer is environmental-friendly, has no toxic or harmful effects. The slurry can also be used for earthworm, pearl and mushroom cultivation as well as for sprouting seeds. Nutrients from the organic sources are more efficient than those from chemical sources. Bioslurry is a 100% organic fertilizer most suitable for organic farming of some high value field and horticultural crops including vegetables, fruit, flowering as well as ornamental plants. This organic fertilizer can also profitably be used for forest nurseries, public parks and roadside plantations.

Organically produced crops and fruits are healthy and nutritious, and have better shelf life as well as higher market value. Demand for organically produced crops are increasing day by day in Bangladesh and elsewhere in the world (Islam and Momin 2004).

Both cow dung or poultry litter bioslurry can be fitted into the modern soil fertility management program popularly known as Integrated Plant Nutrition System, which combines the use of organic and chemical fertilizers. Thus, the use of bioslurry from the biogas plants can reduce the application of at least 40-50% of chemical fertilizers, which may otherwise increase acidity/alkalinity in soils and deteriorate their physical conditions.

Results of Field Trials/Demonstrations

Review of the research works carried out in Bangladesh has shown that hardly any work has been done on bioslurry organic fertilizers. There are some sporadic reports on the use of aerobically decomposed cow dung, poultry litter and compost on field and horticultural crops. After the introduction of fertilizer responsive high yielding and hybrid varieties of crops, the use of chemical fertilizers has increased manifolds. But the use of organic manure as a supplementary source of nutrients has been ignored.

Grameen Shakti (2006) conducted an observational field trial in Grey Floodplain soils in Manikganj to study the effects of cow dung and poultry litter bioslurry on cabbage, brinjal and tomato during the Rabi (winter) season of 2005-06. Treatment combinations were: Control (native fertility), 100% RD (recommended dose), and 50% RD + CD bioslurry (2t/ha), 50% RD+PL bioslurry (2t/ha), 10% RD+ CD bioslurry (2t/ha) and 10% RD+ PL bioslurry (2t/ha). Sun dried bioslurry was added at the rate of 2 tons/ha in two installments- first installment was applied along with chemical fertilizers at the time of planting and the second installment as top dressed after 30 days of planting. All the crops responded dramatically to added bioslurry. The results of the field trials are summarized in Table 2.

Table 2. Effect of bioslurry on the yield of cabbage, brinjal and tomato.

Treatment	Cabbage (T/ha)	Brinjal (T/ha)	Tomato (T/ha)
Control (native fertility)	10.00	5.50	6.50
100% RD	56.50	26.30	24.00
50% RD+CD bioslurry	58.60	24.00	25.00
50% RD+PL bioslurry	60.00	25.00	27.00
10% RD+CD bioslurry	44.00	15.00	16.00
10% RD+PL bioslurry	48.00	17.00	18.50

CD- Cow dung, PL- Poultry litter, Recommended dose for cabbage- $N_{200}\,P_{60}\,K_{120}\,S_{30}$ kg/ha, Recommended dose for Brinjal- $N_{150}\,P_{60}\,K_{120}\,S_{30}$ kg/ha, Recommended dose for Tomato- $N_{150}\,P_{60}\,K_{120}\,S_{30}$ kg/ha.

It is quite evident from the trial that bioslurry had favorable influences in increasing the yields of the crops under study. The yield responses were comparable with those of recommended fertilizer doses. It is possible to reduce the application of chemical fertilizers up to 50%. Between the two, poultry litter bioslurry proved superior to cow dung bioslurry because of presence of more nutrients in it. In another trial with papaya conducted in Grey Terrace soils at Bhawal Mirzapur, Gazipur poultry litter bioslurry produced significant effects than the cow dung on the yield of fruits. It was noted that fruits obtained from bioslurry applied plots were sweeter than the chemical fertilizers applied plots.

Faridpur Muslim Mission (2006) has been using raw bioslurry (about 3000 litters/ha) of its 6-biogas plants run with poultry litter of 30,000 birds for growing various vegetables in its farm. The Mission does not use any chemical fertilizers. The yields obtained for Indian spinach, red amaranth, cucumber, cabbage, cauliflower, brinjal, tomato and radish are comparable with those obtained from recommended doses of chemical fertilizers.

Raj Poultry farm (2006) has been demonstrating its bioslurry both as raw and sundried for various field and horticultural crops. The rate of bioslurry application is 3000 litters as raw and 1 ton/ha as sundried material. The owner of the farm has reported that only small amount of urea and potash (20% of the national recommendation) is added to supplement nitrogen and potash nutrients. He has been harvesting bountiful crops by applying bioslurry organic fertilizers. The remarkable yield increase has been observed on onion crop, which is one of the major crops in his area. With application of 50% recommended dose ($N_{120}\,P_{40}\,K_{60}\,S_{20}$ kg/ha) plus 1ton bioslurry/ha he has obtained 1.5 times more yield (15-17 t/ha) of onion this year (2006) than he usually gets from a normal crop with only chemical fertilizers using the popular variety Taherpuri.

Majumder (2006) enriches K content in bioslurry of his 6-biogas plants through feeding chopped water hyacinth along with cow dung and poultry litter as raw materials. He uses bioslurry for production of seed potato and other winter vegetables in Comilla areas. With application of 2 tons of slurry along with only 20 kg N/ha, he can harvest 20 tons of seed potato plus another 5 tons of table potato. The yield of vegetable crops is higher than those grown with recommended chemical fertilizers. The reduction of the use of chemical fertilizers is significant. He advises his contract growers to use the same practice as he follows in his farm.

Use of Organic Fertilizers

Organic fertilizers 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 recent energy crisis, the cost of chemical fertilizers in the international market has gone up and organic fertilizers have once again been gaining popularity. Environmental pollution due to use of chemical fertilizers has also become an international issue. Proper processing of organic wastes and residues for use in agriculture appears to be promising and this can reduce the environmental pollution to a great extent.

The nutrient content of the commonly used organic fertilizers including bioslurry in the country is shown in Table 3 (Islam 2006). It is seen that slurry contains more nutrients than the ordinary organic fertilizers.

Table 3. Nutrient concentrations in commonly used organic fertilizers of Bangladesh.

Organic fertilizers	Nutrient content (%)		
	N	P	K
Cow dung	0.5-1.5	0.4-0.8	0.5-1.9
Poultry manure	1.6	1.5	0.85
Compost (common)	0.4-0.8	0.3-0.6	0.7-1.0
Farmyard manure	0.5-1.5	0.4-0.8	0.51-1.9
Water hyacinth compost	3.0	2.0	3.0
Bioslurry (cow dung)	1.29	2.80	0.75
Bioslurry (Poultry litter)	2.73	3.30	0.80
Rice straw	0.52	0.25	1.20
Wheat straw	0.63	0.28	0.80
Maize stove	0.45	0.30	0.70
Sugarcane trash	0.35	0.25	0.80
Tobacco stems	0.42	0.25	1.10

As mentioned before, not enough experimental data are available in Bangladesh to quantify the responses of different crops to added organic manure. However, meager information available indicates that vegetable crops respond significantly with increasing

rates of application up to 15 tons/ha. Responses are more distinct in the terraces than in the floodplain soils. The most responsive vegetable crops are cabbage, cauliflower, brinjal, tomato and potato. Other vegetables such as Indian spinach, lady's finger, spinach, red amaranth, onion and garlic produce significant yield increases when they are fertilized with organic manure along with chemical fertilizers.

Uddin *et al*. (2005) found that BRRI dhan29 produced highest grain yield (7.50 t/ha grain yield) compared with other rice varieties when fertilized with poultry manure (5t/ha) + urea super granule (175 kg).

Table 4. Effect of urea super granule on boro rice.

Variety X Sources of fertilization	Yield (t/ha)	
	Grain	Straw
BRRI dhan28 X PU	4.25	5.10
BRRI dhan29 X PU	5.50	6.50
BRRI dhan36 X PU	3.66	4.66
BRRI dhan28 X USG	5.16	6.41
BRRI dhan29 X USG	5.66	7.00
BRRI dhan36 X USG	3.75	4.33
BRRI dhan28 X (Cowdung + USG)	4.13	4.41
BRRI dhan29 X (Cowdung + USG)	5.66	6.33
BRRI dhan36 X (Cowdung + USG)	5.16	6.00
BRRI dhan28 X (Poultry manure + USG)	4.13	5.00
BRRI dhan29 X (Poultry manure + USG)	7.50	8.91
BRRI dhan36 X (Poultry manure + USG)	5.16	6.00
Level of significance	0.01	0.01

PU- prilled urea USG- urea super granule

Noor et al. (2005) at the Bangladesh Agricultural Research Institute (BARI) evaluated some organic manure on the yield of cabbage under integrated nutrient management system during the Rabi seasons of 2000-01 and 2001-02 in Grey Terrace soils of BARI central farm. The highest mean yield (87.10 t/ha) was obtained from treatment 70% RD + 5 t oil cake/ha, which was significantly higher over all other treatments except treatment 70% RD +10 t poultry manure/ha and treatment 70% RD + 2.5 t oil cake/ha. The second highest mean yield (84.75 t/ha) was obtained from treatment 70% RD + 2.5 t oil cake/ha followed by treatment 70% RD +10 t poultry manure/ha, which was statistically identical with treatment 70% RD + 5 t oil cake/ha but significantly greater over rest of the treatments. The treatment package 70% RD +5 t poultry manure may be recommended for the marginal farmers whereas resource rich farmers may use either treatment 70% RD + 2.5 t oil cake/ha or treatment 70% RD +10 t poultry manure/ha for maximum gross margin.

Table 5. Yield of cabbage (t/ha) as affected by integrated nutrient management system during Rabi seasons of 2000-01 and 2001-02.

Treatment	2000-01	2001-02
100% RD	67.36	61.82
70% RD	52.86	45.2
70% RD+ Cow dung (5 t/ha)	60.44	57.22
70% RD+ Cow dung (10 t/ha)	70.76	65.56
70% RD+ Poultry manure (5 t/ha)	73.32	74.86
70% RD Poultry manure (10 t/ha)	81.28	81.80
70% RD + Oil cake (2.5 t/ha)	84.88	84.62
70% RD + Oil cake (5 t/ha)	87.25	86.94
Native fertility (Control)	22.14	19.74
CV (%)	5.6	6.4

RD= Recommended dose-N_{250} P_{36} K_{80} S_{40} B_2 Mo_1 kg/ha

Production of Organic Fertilizers

The farmers of Bangladesh hardly follow any scientific methods to produce organic fertilizers. According to Razzak (2006) and Alam (2006), about 7 million tons of organic fertilizers are produced every year from animal wastes, household wastes, city wastes, crop wastes. The farmers usually dispose the animal wastes mainly dung in open pit at their farmyard and leave them at least three months before they use for their crop fields.

However, many private companies are now coming forward to produce organic fertilizers commercially. For commercial marketing the government has so far standardized about 28 organic and organochemical fertilizers. It is learnt that another 20 companies have applied for standardization of their organic and nutrient enriched organic fertilizers. Therefore, it is important that standard methodology should be followed by the companies as well as by the farmers in producing quality organic fertilizers.

Quality of Organic Fertilizers

Organic fertilizers are added to the soils with a view to producing desirable physical, chemical and biological improvement. This condition is very much needed for proper growth and development of crop plants. Therefore, organic fertilizers should be well decomposed and shall not have any detrimental effects.

A good quality organic fertilizer should have the following characteristics:

i) Is dark brown to black in colour
ii) Has C: N ratio ranging from 10 to 20
iii) Is insoluble in water
iv) Has high capacity for cation exchange
v) Has a high water retention capacity
vi) Has a beneficial effect both on the soil and the growing vegetation

Agronomic Importance of Slurry Organic Fertilizer

The agronomic value of slurry and other organic fertilizers is generally expressed in terms of increased yield and high quality. The response to these fertilizers is quite variable and depends on a number of factors such as crop varieties, soil types, climatic conditions, management system and the material used for its production.

Macronutrient Availability

Organic fertilizers, when added to the soils, undergo decomposition. As a result, nutrients are released and become available for plant uptake. The rate of decomposition or mineralization depends on soil conditions as well as the kind of organic fertilizers.

Nitrogen availability from the slurry organic fertilizers are quite significant and dramatic both in waterlogged and upland soils. Total nitrogen content increases and benefits the crop.

Phosphate availability also increases. The most significant effect from application of organic fertilizers especially from the poultry bioslurry is the decrease in phosphate fixation by sesquioxides. Organic acids produced as a result of application of organic fertilizers are most efficient in releasing phosphorus from rock phosphate and tricalcium phosphate.

Organic fertilizers are also a good source of potassium when water hyacinth is used in their production. Source of native sulphur in the soil is organic matter coming from organic fertilizers. Calcium and magnesium supply from poultry litter bioslurry is substantial and the soils are enriched adequately when it is added to them.

Micronutrient Availability

Continuous use of organic fertilizers increases the micronutrient availability. If soil is critically deficient in zinc, boron and molybdenum, external application of mineral fertilizers would be needed to meet up the requirement. The availability of iron, manganese, copper and chloride in Bangladesh soils is not a problem as they are abundantly available.

Economic Value of Organic Fertilizers

Due to changing scenario of soil fertility management with emphasis on organic matter replenishment, the organic fertilizers could play a vital role in restoring fertility as well as organic matter status of the soils. However, the economic value of organic fertilizer to a farmer is the value of increase in crop yields and/or crop quality that is derived from its use. The cost benefit ratio will determine the economic aspects of its use. It is to be remembered that besides supplying essential plant nutrients, organic fertilizer, irrespective of its sources, produces desirable physical, chemical and biological changes in soils.

Present Soil Fertility Conditions

The fertility status of Bangladesh soils is extremely variable (Appendix I). Most of the soils are depleted and decline in crop yields have been recorded in recent times. The farmers use fertilizers indiscriminately without adequate information on actual soil/plant requirement.

This results in over application of some nutrients, under application of others and general inefficiency of the costly fertilizer input.

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.

Urea is the widely used chemical fertilizer to correct its deficiency.

Phosphorus

Phosphorus is the second most important nutrient element limiting successful crop production. It becomes unavailable when 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. Significant role of phosphate application in sustaining and building up soil fertility for various upland crops is well recognized.

The commonly used phosphate fertilizers are TSP, DAP and SSP.

Potassium

Potassium is the third major plant nutrient recently identified as deficient in most Bangladesh soils. Alluvial soils of Bangladesh are comparatively rich in potash bearing minerals than the terraces that are older. These soils may not release K fast enough to match the crop requirements especially for the HYVs 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.

Muriate of potash is commonly used to potash deficiency.

Sulphur

Sulphur has been recognized as the fourth major nutrient limiting crop production since 1980.The use of high analysis fertilizers such as urea, TSP, MOP and DAP, cultivation of HYVs, increasing cropping intensities and limited application of organic fertilizers have all contributed to the intensification of the S deficiency problem in the soils of Bangladesh. The problem is more severe in wetland rice than in upland crops.

Gypsum or SSP is used to correct sulphur deficiency

Other nutrients

The deficiencies of magnesium, zinc, boron and molybdenum have been detected in many soils where the applications of these nutrients have produced significant yield increases.

Use of Chemical Fertilizers

The use of chemical fertilizers in Bangladesh agriculture started with import of 2698 tons of ammonium sulphate during the year 1951-52. 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 about 4.0 million tons during 2005-06(Appendix II). Along with urea, phosphate and potash the use of gypsum, zinc sulphate and other micronutrients were also increased. During 2004-06 considerable amounts of NPKS mixed fertilizers were used in an attempt to make balanced fertilization.

Domestic Production

In Bangladesh urea, TSP and SSP are produced in the local industries, which can partly meet the total demand of the country (Appendix III). About 60,000 tons of phosphogypsum is produced as a byproduct from TSP factory. At present there are six urea and one TSP fertilizer 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 have the capacity to produce 2.32 million tons of urea; 12,000 tons of ammonium sulphate; 65,000 tons of TSP and 120,000 tons of SSP. Additional requirements of about 500,000 tons of urea are met up from import. Additional requirements of TSP and gypsum are also imported. All MOP and DAP are imported.

There are more than 50 small zinc sulphates manufacturing factories in the country. These are mostly concentrated around Jessore-a southwestern district. These factories can produce 10/12 thousand tons of granular monohydrate and crystalline heptahydrate zinc sulphate. Some companies produce small amounts of boric acids also.

Conclusions and Recommendations

To reduce poverty and malnutrition as well as to attain and sustain self-sufficiency in food and fibre crops within shortest possible times, intensification of agricultural production by multiple cropping, increasing cropping intensity and the use of high yielding varieties is a must. Such challenging activities that are very much needed for obtaining food security throughout the country involve a complete management package that depends heavily on plant nutrient supply and balance. Under such situations, mineral fertilizers alone cannot correct all the deficient nutrients in the soils. Due to high oil prices in the internal market and shrinking natural resources for fertilizer production, the prices of the imported fertilizers will continue to increase in the coming years. Therefore, mobilization of all native organic resources and recycling them into soil fertilization program should be undertaken without any delay. Biogas technology is one such program that should be promoted with all out efforts by the government agencies, private companies, different NGOs as well as philanthropic organizations. This technology not only provides energy for multiple uses, but also supplies good quality slurry that can be used as quality organic fertilizer in our depleted soils. Bioslurry supplements soils not only with NPK nutrients, but also with secondary and micronutrients, and improve soil conditions favorable for high crop productivity. With the organic resources available everyday, it is possible to construct about 4,000,000 biogas plants in the country. From these plants a huge quantity of organic fertilizer will be obtained for land application and thus the use of chemical fertilizers could be reduced significantly up to 50 % or even more. The Government has been subsidizing heavily urea fertilizers since long and introduced 25% subsidy on imported TSP, DAP and MOP fertilizers. Therefore, to harness immense potential opportunities of biogas technology, the Government should

come forward and provide at least **40-50% subsidy to biogas program** and thus encourage private companies/NGOs in promoting this technology for **solving growing fuel crisis in rural households** as well as **fertilizer crisis in Bangladesh agriculture**.

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Appendices

Appendix 1. Nutrient status of some important soils series of Bangladesh.

Soil series	pH	OM (%)	meq/100g			μg/g							
			Ca	Mg	K	NH_4-N	P	S	B	Zn	Cu	Fe	Mn
Tejgaon	5.1	1.5	0.7	0.45	0.17	8	4	10	0.5	2.0	3	272	27
Chhiata	5.3	0.6	2.0	0.57	0.12	2	5	4	0.5	2.0	3	291	23
Kalma	5.1	1.7	1.5	0.28	0.16	5	3	10	0.4	2.0	8	301	15
Khilgaon	5.0	1.6	2.0	1.57	0.21	12	14	12	0.3	5.0	6	200	10
Savar	5.6	1.5	3.0	1.62	0.11	13	18	23	0.9	3.9	10	100	20
Sonatola	5.7	1.3	1.6	0.83	0.12	5	15	8	0.1	1.0	4	42	9
Ghatail	6.2	1.1	2.0	0.77	0.10	12	2	12	0.4	1.0	5	150	7
Shilmandi	5.4	0.9	1.2	0.67	0.11	10	5	8	0.3	2.0	10	204	25
Bonarpara	6.5	1.0	1.6	0.68	1.11	13	5	8	0.3	2.0	6	203	9
Kaunia	6.4	1.0	4.3	0.85	0.47	9	7	10	0.1	2.0	9	94	5
Gangachara	6.5	1.2	1.5	0.51	0.15	7	10	12	0.5	1.0	6	38	10
Polashbari	6.0	0.9	3.5	0.69	0.15	6	11	4	0.1	1.0	4	42	9
Gopalpur	7.7	1.4	23.0	4.00	0.22	2	10	4	0.3	1.5	3	25	5
Sara	7.9	0.9	18.7	2.50	0.15	16	16	4	0.3	1.0	8	24	14
Ghior	6.8	1.2	8.0	2.50	0.34	5	8	10	0.2	1.0	3	140	13
Darsona	8.0	1.4	20.0	4.00	0.33	7	8	9	0.3	1.0	5	65	7
Domar	6.0	1.0	1.5	0.5	0.20	4	10	5	10	0.1	4	50	Tr
Barkal	5.5	1.4	1.6	0.9	0.43	14	12	10	0.1	1.4	3	180	16
Mirpur	7.2	0.8	4.0	1.70	0.15	3	10	5	0.1	1.0	3	116	6
Lauta	5.2	1.6	1.6	0.70	0.18	2	9	2	0.1	1.0	3	211	4
Ekadala	5.6	1.5	1.7	0.71	0.16	8	10	11	0.1	1.0	3	211	5
Ishurdi	7.9	1.3	18.0	1.20	0.30	5	7	4	0.4	0.4	3	26	3
Amnura	5.5	0.9	3.0	1.62	0.10	5	2	6	0.3	2.0	5	30	4
Chandina	5.5	1.5	2.8	1.24	0.07	10	5	10	0.3	2.0	7	413	27
Debidwar	5.7	1.2	2.7	0.92	0.15	7	12	10	0.5	1.0	4.6	243	22
Nachole	6.3	1.3	3.0	2.0	0.27	5	12	8	0.4	1.7	5	270	10
Amjhupi	7.2	1.5	19.0	4.08	0.22	3	4	6	0.2	1.5	6	28	25
Kaptai	5.3	1.8	2.1	1.0	0.17	8	10	11	0.1	1.0	3	589	113
Jaflong	5.4	0.8	Tr	0.12	0.07	3	4	6	0.3	1.0	1	144	7
Critical Level			2.0	0.8	0.20	75	14	14	0.2	2.0	1	10	5

Tr-Trace

Appendix 2. Consumption of different fertilizers (tons) in Bangladesh during last ten years.

YEARS	UREA	TSP	SSP	DAP	MP	GYPSUM	ZINC SULPHATE	AS	OTHERS	TOTAL
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	2121000	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

Appendix 3. Domestic Fertilizer Production during last ten years (1994-95 to 2005-06).

Year	Production (tons)		
	Urea	TSP	SSP
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