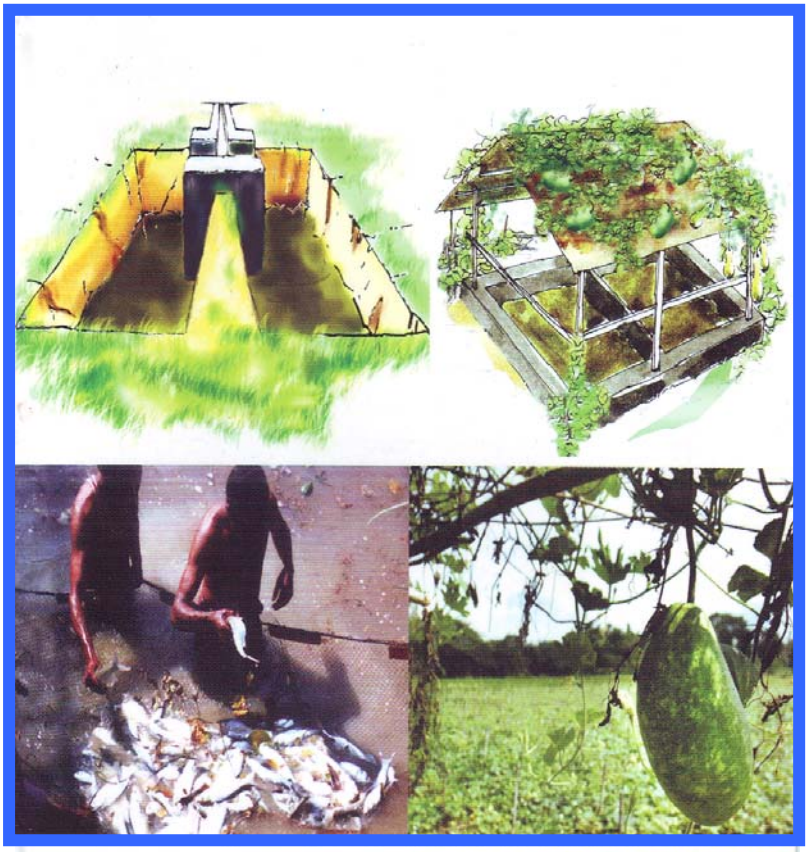
PROJECT REPORT

ON

BIO-SLURRY MANAGEMENT AND ITS EFFECT ON SOIL FERTILITY AND CROP PRODUCTION



BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
SOIL SCIENCE DIVISION & ON-FARM RESEARCH DIVISION
GAZIPUR 1701

September 2008

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BIO-SLURRY MANAGEMENT AND ITS EFFECT ON SOIL FERTILITY AND CROP PRODUCTION

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SEPTEMBER 2008

CONTENT

EXECUTIVE SUMMARY

A project on 'Bio-Slurry Management and Its Effect on Soil Fertility and Crop Production' was implemented during the period of October' 2007 to August' 2008. Soil Science Division (SSD) and On Farm Research Division (OFRD) of Bangladesh Agricultural Research Institute (BARI) involved in this project. Soil Science Division confined with laboratory & on station field study where as On Farm Research Division conducted on farm research activities in different locations across the country. Manural quality of Bio slurry (28 sample) and slurry compost (6 sample) were studied. Nutrient content of both cowdung (CD) slurry and poultry manure (PM) slurry were higher than aerobically decomposed cowdung and poultry manure. Cobalt, nickel, cadmium and arsenic content of cowdung & poultry manure and their bio slurry were within the safe limit. Lead concentration of poultry manure, PM poultry slurry and PM slurry compost were higher than that of cowdung, CD slurry and CD slurry compost. Two poultry manure, 4 PM slurry and 1 PM compost samples contained lead more than 30 µg/g and were not suitable for use as organic manure. Heavy metal concentration follows the order of : Poultry manure > PM Slurry > PM compost.

Two on-stations experiment were conducted at BARI Central Farm, Gazipur to evaluate the performance of bio-slurry on yield and nutrient uptake of cabbage and cauliflower. Six nutrient management packages viz. inorganic fertilizer, IPNS with Cowdung, IPNS with Cowdung slurry, IPNS with poultry manure, IPNS with poultry manure slurry and native fertility were tested on cabbage and cauliflower. Higher yield of cabbage (89.16-93.65 t/ha) and cauliflower (49.56-53.77 t/ha) were obtained from the slurry treated plots. Nutrient uptake was higher in both organic and inorganic fertilizer treated plot compared to no fertilizer treated plot. However, the treatment where poultry slurry was used showed higher yield and higher economic performance.

Field experiments were conducted at different locations (Pabna, Jessore, Rangpur, Tangail, Gazipur, Comilla, Bogra, Mymensingh and Faridpur) to observe the effect of bio-slurry on the performance of different crops (Tomato, Cabbage, Cauliflower, Potato, Maize, Boro rice and Wheat) during 2007-08. Four nutrient management options viz. inorganic fertilizer, IPNS with cowdung/poultry manure, IPNS with cowdung slurry/poultry slurry and farmers' management along with native fertility were tested on the crops. The yield of the crops was significantly influenced by the different nutrient management options. A positive response of slurry was found on the crops. Higher yield of tomato in Pabna, Jessore and Rangpur, higher cabbage yield in Gazipur, Tangail and Jessore, higher yield of cauliflower in Gazipur and Tangail, higher yield of potato in Rangpur, higher grain yield of Boro rice in Mymensingh and higher yield of maize was found in Pabna and Rangpur. Higher economic return was recorded from slurry in most cases.

A total of 15 scientists of SSD and OFRD were trained on the management and utilization of bio-slurry through one day training programme. A one day training programme for Co-operator farmers of Gazipur & P O Supervisors (20 participant) on the use of bio-slurry in homestead vegetable garden was organized at BARI, Gazipur. A total of 40 farmers were trained on Bio-slurry management at Pabna, Rangpur, Tangail, Faridpur and Mymensingh

1.0 Introduction

Bio-gas technology is becoming popular in rural Bangladesh in view of escalating costs of fuels as well as soaring prices of chemical fertilizers which our farmers find difficult to buy for their sustainable crop production. First biogas plant was constructed in 1972 at the premises of Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. After that through several projects under different organizations constructed about 24 thousands of biogas plants in different parts of the country. Infrastructure Development Company Limited (IDCOL) is implementing National Domestic Biogas and Manure Programme (NDBMP) with support from the Netherlands Development Organization (SNV) and likely support from KFW, Germany. Under this programme a total of 60,000 biogas plants will be constructed during 2006-2010. Huge amount of biogas slurry may come out from these plants. Major emphasis for construction of those biogas plants was given for cooking and lighting purpose. Utilization of bio-slurry was not addressed adequately and properly though it has potential value for use as good quality fertilizer in maintain soil fertility and crop production and feed for fish culture in our farming systems. Again, price of chemical fertilizers increasing day by day. Preliminary investigations show that both cow dung and poultry litter slurry contain considerable quantities of plant nutrients, which may be used to improve soil fertility and thus the use of chemical fertilizers can be reduced to a great extent. Poultry litter based slurry is especially suitable for acid soils as it has strong liming effect.

In Bangladesh, major food crops remove about 2.98 million tons of nutrients annually against a total addition of 0.72 million ton (Mondal, 2000). According to an appraisal report of Bangladesh soil resources, soils of about 6.10 m ha contain very low (less than 1%) organic matter, 2.15 m ha contain low (1-2%) organic matter and the remaining 0.90 ha contain more than 2 % organic matter (Mondal, 2000). A good soil should have an organic matter content of at least 2.5% (BARC, 2005). The average organic matter content of top soils has decline by 20-46% over past 20 years due to intensive cropping without inclusion of legume crops, imbalance use of fertilizer, use of modern varieties and scanty use of organic manure. It is agreed that decrease in soil fertility is a major constraint for higher crop production in Bangladesh. The beneficial effect of organic manure in crops production has been demonstrated by many workers (Joshi *et. al.*, 1994; Batsai *et. al.*, 1979; Singh *et al.*, 1970 and Subhan, 1991). Maintenance of soil fertility is a prerequisite for long term sustainable crop production and it is certain that organic manure (cowdung, poultry manure and their slurry) can play a vital role in the sustainability of soil fertility and crop production. So, the maintenance of soil organic matter is a burning issue both for the farmers and agricultural scientists. Biogas is popular in Bangladesh due to high cost of fuel and fertilizer. Bio-slurry can improve the physical and biological quality of soil by adding organic matter to the soil. It also provides both macro and micro-nutrients to crops.

Research work on the quality of bio-slurry and its effect on performance of crops grown in different soils and environment is lacking in Bangladesh. Therefore, it is important to evaluate the quality of bio-slurry and its effect on performance of different crops and soil fertility.

2.0 General Objectives

1. Generate information on plant nutrient value and heavy metal concentration of bio-slurry from different organic materials used as substrate.
2. Generate information/extension message on best method of preserving and composting of bio-slurry.
3. Quantify the agronomic and economic effectiveness of slurry materials in increasing yield of major crops and maintaining/improving soil fertility in varied agro-ecological conditions.
4. Determine best extension method (s) for slurry utilization.

3.0 Planned activities

The following activities were planned:

- Collection of literature on bio-slurry and its management and utilization
- Conduction of research
    - Laboratory analysis
    - On-station trials
    - On-farm trials
- Imparting training
- Monitoring
- Preparation of report

4.0 Outcome

4.1 Literature Collection

Application of bio-slurry gave significantly higher yield in vegetables were reported by Joshi *et al.* (1994). Application of 10 t ha^{-1} cowdung (CD) or CD slurry gave moderate yield (77.5 t ha^{-1}) of tomato. Application of bio-slurry 5 t ha^{-1} along with 75% recommended dose of chemical fertilizer out yielded the full dose of recommended chemical fertilizer (Sen *et al*., 2007). Jayakumar and Elangovan (1993) found that biogas slurry @ 300 g pot^{-1} produced the largest head of Sun flower. Application of biogas slurry increased cob yield of maize were reported by Manna and Hazra (1996). Among the 4 organic manure, PM slurry was found best for cabbage production and soil health followed by PM, CD slurry and CD (Sen *et al*., 2007). Batsai *et al*. (1979) reported that chemical fertilizer along with organic manure produced the highest cabbage yields. Smith (1950) reported that uric acid, which constituted 60 per cent of the nitrogen in poultry manure, changes rapidly to ammoniacal form which

is utilized by the plants. Another important factor contributing to the higher yield with PM might be their higher N content or increased availability of native soil nitrogen through increased biological activity. The field under experiment was poor in N content. Brown (1958) observed that PM contained growth promoting hormones which produced better root growth.

4.2 Research

4.2.1 Laboratory analysis

The status of laboratory analysis of soil, plant and bio-manure samples is given in Table 1.

Table 1. Status of laboratory analysis of soil, plant and bio-manure samples

Item	Planned number of samples			Number of samples analysed		
	Biomanure	Soil	Plant	Biomanure	Soil	Plant
Soil Samples-Initial	-	77	-	-	52	-
- Post harvest	-	48	-	-	48	-
Plant Samples	-	-	194	-	-	194
Manure Samples	231	-	-	45	-	-

Bioslurry project was started in the month of November which was one month delay from starting rabi season. Again Tornedo 'SIDR' attacked most of the area of Bangladesh in November 15, 2007 causing serious damage of crop, infrastructure and other wealth. For this reason all the trial. As a result, some of the on farm trials were not conducted. So, the analysed initial soil and manure sample were less than the planned number of samples.

EVALUATION OF BIO SLURRY AND SLURRY COMPOST AS A SOURCE OF ORGANIC MANURE

Abstract

An investigation was conducted to determine manural quality for Bio slurry and slurry compost during January to April, 2008. Bio slurry samples are collected from Biogas plant and slurry compost are prepared from Bio-slurry. A total of 28 Bio slurry sample were collected of which 16 are cowdung based and 12 are poultry based. Six slurry compost samples were collected of which 3 are CD based and 3 are PM based. Five cowdung sample and 6 poultry manure sample are also analysed to compare with Bio slurry and slurry compost. These samples were analysed for essential plant nutrient which included pH, OM, Ca, Mg, K, N, P, S, B, Cu, Fe, Mn and heavy metals like Co, Ni, Cd, Pb & As. According to organic matter content, 1 sample contained less than 17% organic matter and was unsuitable for use as organic manure. As regards to different plant nutrients, all cowdung & poultry

manure and their Bio-slurry & slurry compost samples were suitable for use as organic manure. Nutrient content of both CD slurry and PM slurry were higher than aerobically decomposed cowdung and poultry manure. Percent moisture content of Bio slurry and slurry compost were within the safe limit. Cobalt, nickel, cadmium and arsenic content of cowdung & poultry manure and their bio slurry were within the safe limit. Lead concentration of poultry manure, poultry slurry and PM slurry compost were higher than that of cowdung, cowdung slurry and CD slurry compost. Two poultry manure, 4 PM slurry and 1 PM compost contained lead more than 30 µg g^{-1} and are unsuitable for use as organic manure. Heavy metal concentration follows the order of : Poultry manure > PM Slurry > PM compost.

Introduction

Biogas is potential renewable energy alternative to the energy produced from firewood, the cutting and burning of which is harmful for the environment. The technology uses cowdung, poultry litter, water hyacinth and other biomass wastes to produce biogas thereby ensuring a smoke-free, odor free, clean and healthy cooking environment for rural women.

More than 30,000 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 and dairy farms are in operation in the country. These biogas plants generate more than 200,000 tones of bioslurry on dry weight basis. This bioslurry is equivalent to about 9,000 tons of urea + 25,000 tones of MP plus other secondary and micronutrients. About 20 organizations involved in transferring biogas technology with the help of IDCOL and SNV, Bangladesh. With the organic resources available in the country, it is possible to construct more than 4 million biogas plants.

Bioslurry, released from hydraulic chamber is an anaerobically decomposed organic material of cow dung, poultry litter, water hyacinth, human excreta and other organic wastes. No effective program has been undertaken to use bioslurry in agriculture. Although digested dung bioslurry has a low content of N, P and K as compared to chemical fertilizers, it is a valuable source of humus substance (Gaur *et al.*, 1984). Preliminary investigations show that both cowdung and poultry litter bioslurry contain considerable quantities of plant nutrients, which may be used to improve soil fertility and thus the use of chemical fertilizers can be reduced to a great extent. Poultry litter bioslurry is especially suitable for acid soils as it has strong liming effect. It reduces the acidity of the soils and thereby protects crops from aluminum toxicity. These organic fertilizers can effectively be utilized for organic farming for high value crops that is the demand of the day in Bangladesh and elsewhere.

Again there is a controversy that poultry litter contained appreciable amount of toxic heavy metal. Bio slurry contained more plant nutrient than aerobically decomposed cowdung and poultry manure. Slurry compost is higher manural value than Bio slurry. Recently MOA fix the criteria for organic manure. So, it is imperative to evaluate cowdung & poultry manure and their bio slurry & slurry compost as a source of organic manure.

Objectives:

1. To know the manural value of bioslurry using different substrats.
2. To determine the heavy metal status of bioslurry.
3. To evaluate the bioslurry as organic manure.

Materials and Methods

An investigation was conducted to determine manural quality for Bio-slurry and slurry compost during January to April, 2008. A total of 28 bio slurry samples were collected of which 16 were cowdung based and 12 poultry based. Six slurry compost samples were collected of which 3 were Cowdung based and 3 were Poultry litter based. Five cowdung samples (aerobically decomposed) and 6 poultry manure samples (aerobically decomposed) were also analysed to compare with Bio slurry and slurry compost. Bio slurry samples were collected in plastic pot from pit. Bio slurry samples were air dried. Moisture percentage of air dry cowdung & poultry manure and air dry bio slurry & slurry compost were determined gravimetrically. pH of these samples were determined immediately by pH meter. These samples were analysed for OM, N, P, K, S, Ca, Mg, Zn, B, Cu, Fe, Mn and heavy metals like Co, Ni, Cd, Pb & As. Analytical results of cowdung & poultry slurry and their slurry compost are evaluated through standard criteria fixed recently by the government of Bangladesh. Analytical value within the acceptable range are suitable for use as organic manure and out side the acceptable range are considered not suitable for use as organic manure.

Results and Discussion

Moisture content, pH, organic matter and nutrient status of organic manure, bio slurry and slurry compost is presented in Table 2.

Moisture Content

Percent moisture of collected samples is presented in Table 2. Mean percent moisture of CD slurry (14.4%) & PM slurry (12.6%) were higher than that CD (11.8%) and PM (11.6%). Least moisture percentage was present in CD compost (9.7%) and PM compost (9.0).

pH

pH value of poultry litter based manure, slurry & slurry compost are higher than that of cowdung based manure, slurry & slurry compost. pH of cowdung manure ranging from 6.0 to 7.0, cowdung slurry ranging from 5.6 to 7.7 & cowdung compost ranging from 6.1 to 6.7.

Organic matter content

Average organic mater content was higher in CD (20%) & CD slurry (25%) than that of PM (19%) & PM slurry (19%). Bio slurry of cowdung and poultry litter contains acceptable range of organic matter as fixed by MOA, GOB (Gazzetted 2008).

Table 2. Percent moisture, pH and nutrient status of different organic manure sources

Source of Org. Man.	Range	% moisture	pH	OM %	Ca	Mg	K	N	P	S	B	Cu	Fe	Mn	Zn
					meq/100 ml			%							
Cowdung (Sample-5)	Min.	9.3	6.0	17	0.5	0.16	0.13	1.04	0.4	0.2	0.01	0.002	0.20	0.03	0.006
	Max.	13.2	7.0	22	3.7	0.69	0.48	1.27	1.1	0.4	0.12	0.005	0.34	0.10	0.036
	Mean	11.8	6.4	20	2.0	0.52	0.23	1.02	0.7	0.3	0.05	0.003	0.23	0.07	0.018
CD Slurry (Sample-16)	Min.	13.2	5.6	16	0.7	0.25	0.17	1.20	0.5	0.2	0.01	0.002	0.24	0.04	0.008
	Max.	16.4	7.7	44	8.2	1.74	0.60	1.52	1.4	0.6	0.27	0.007	0.39	0.13	0.056
	Mean	14.4	6.3	25	2.2	0.89	0.33	1.37	0.8	0.3	0.06	0.003	0.34	0.09	0.021
CD compost (Sample-3)	Min.	8.8	6.1	21	2.6	1.06	0.16	1.66	0.5	0.4	0.01	0.002	0.34	0.05	0.011
	Max.	10.4	6.7	23	3.2	2.10	0.50	1.72	1.2	0.5	0.04	0.004	0.42	0.38	0.037
	Mean	9.7	6.6	22	2.9	1.54	0.39	1.69	0.8	0.5	0.02	0.003	0.38	0.13	0.032
Poultry man (Sample-6)	Min.	9.6	6.6	17	3.1	1.09	0.10	1.42	0.4	0.2	0.01	0.002	0.16	0.05	0.009
	Max.	12.8	7.4	21	7.5	2.11	0.63	1.89	1.2	0.5	0.16	0.005	0.32	0.12	0.044
	Mean	11.6	6.9	19	4.9	1.68	0.40	1.71	0.7	0.4	0.06	0.004	0.23	0.07	0.021
PM Slurry (Sample-12)	Min.	10.9	6.0	15	2.9	1.46	0.12	1.63	0.5	0.2	0.01	0.002	0.22	0.06	0.012
	Max.	14.5	7.3	23	8.6	2.74	0.71	2.02	1.4	0.6	0.20	0.008	0.37	0.15	0.056
	Mean	12.6	6.7	19	6.2	2.08	0.48	1.84	0.8	0.3	0.03	0.006	0.29	0.09	0.025
PL Compost (Sample-3)	Min.	8.4	7.4	19	5.0	1.34	0.60	2.27	0.6	0.2	0.01	0.002	0.25	0.05	0.014
	Max.	9.5	8.4	26	8.6	2.16	1.00	2.39	1.4	0.5	0.05	0.007	0.37	0.14	0.041
	Mean	9.0	7.8	22	7.0	1.72	0.80	2.60	0.9	0.4	0.02	0.005	0.33	0.08	0.031
Accepted value (Min.)		0	6.0	17	-	-	-	0.50	0.5	0.1	-	0	-	-	0
Accepted value (Max.)		15	8.5	43	-	-	-	4.00	1.5	0.5	-	0.050	-	-	0.100

Primary nutrient

Average nitrogen content is higher in PM (1.71%) & PM slurry (1.84%) than that of CD (1.02%) & CD slurry (1.37%). In spite of higher OM percentage in Cowdung, % N was higher in poultry manure as because C: N ratio is higher in Cowdung and lower in Poultry manure. Islam (2007) also found that N content is higher in PM than CD. Digested bioslurry samples contained higher amount of N than aerobically decomposed cowdung and poultry manure.

Higher amount of P was present in PM slurry (0.5-1.4%) and CD slurry (0.5-1.4%) compared to PM (0.4-1.2%) and CD (0.4-1.1%). These results confirmed the findings of Joshi *et. al*., 1994.

Mean K content was higher in poultry manure (0.40), poultry slurry (0.48) & PM slurry compost (0.80) than that of cowdung (0.23), cowdung slurry (0.33) & CD slurry compost (0.39).

Secondary nutrient

The concentration of Ca in poultry manure (3.1-7.5), poultry slurry (2.9-8.6) & PM slurry compost (5.0-8.6) were higher than that of cowdung (0.5-3.7), cowdung slurry (7.0-8.2) & CD slurry compost (2.6-3.2).

Similarly, Mg content of poultry manure (1.09-2.11), poultry slurry (1.46-2.74) & PM slurry compost (1.34-2.16) are higher than that of cowdung (0.16-0.69), cowdung slurry (0.25-1.74) & CD slurry compost (1.06-2.10). Because bone meal, fish meal and shell dust used as poultry feed containing appreciable amount of Ca and Mg.

Higher amount of S are present in PM slurry (0.2-0.6%) and CD slurry (0.2-0.6%) compared to PM (0.2-0.5%) and CD (0.2-0.4%). These results confirmed the findings of Joshi *et. al.*, 1994.

Micro nutrients

Micronutrient concentration in bio-slurry was higher than aerobic decomposed manure of cowdung and poultry manure.

Heavy metal

Heavy metal status of collected samples is presented in Table 3. Heavy metal concentration of cowdung and its slurry or compost is much below the level of maximum acceptable value. Concentration of all analysed heavy metals except Pb in poultry manure and poultry slurry is within the acceptable range. Out of the 21 samples, Pb content of 2, 4 and 1 samples of poultry manure, PM slurry and PM compost, respectively are higher than the acceptable value.

Table 3. Heavy metal status of different organic manure

Sources	Range	µg/g				
		Co	Ni	Cd	Pb	As
Cowdung (Sample-5)	Min.	3.2	5.8	0.28	5.2	2.40
	Max.	15.6	20.4	4.16	17.1	7.15
	Mean	9.4	11.6	1.46	26.5	4.72
CD Slurry (Sample-16)	Min.	2.8	4.4	0.20	3.8	1.30
	Max.	12.4	17.0	3.20	29.0	4.20
	Mean	7.3	10.2	0.98	13.2	2.38
CD compost (Sample-3)	Min.	7.0	7.6	0.2	10.8	1.6
	Max.	13.8	13.8	1.0	19.2	1.8
	Mean	9.6	10.7	0.7	15.3	1.7
Poultry man (Sample-6)	Min.	9.5	10.4	0.5	14.2	6.6
	Max.	14.9	19.1	2.2	61.6	15.5
	Mean	12.0	16.2	1.4	38.4	9.20
PM Slurry (Sample-12)	Min.	7.2	8.8	0.4	12.8	5.8
	Max.	10.6	14.8	1.8	185.8	12.2
	Mean	8.4	11.4	1.1	46.4	7.85
PL Compost (Sample-3)	Min.	6.8	7.6	0.4	12.8	4.4
	Max.	11.4	18.2	0.8	38.2	5.7
	Mean	9.8	12.8	0.6	22.7	4.9
Accepted value	Min.	-	0	0	0	0
Accepted value	Max.	-	30	5	30	20

4.2.2 On-station trials

The status of on-station experiment is given in Table 4.

Table 4. Status of on-station experiment

Planned			Executed		
No. of experiment.	No. of crops	No. of sites	No. of experiment.	No. of crops	No. of sites
01	02	02	01	02	02

EFFECT OF BIO-SLURRY ON THE YIELD AND NUTRIENT UPTAKE OF CABBAGE AND CAULIFLOWER

Abstract

Cabbage and Cauliflower are the most important and popular vegetable crops in Gazipur sadar under AEZ 28. An experiment was conducted at BARI Central Farm to evaluate the performance of bio-slurry and promote their adoption by the farmers. The experiment was laid in RCB design with 3 replications. Six nutrient management packages viz. inorganic fertilizer, IPNS with Cowdung, IPNS with Cowdung slurry, IPNS with poultry manure, IPNS with poultry manure slurry and native fertility were tested on cabbage and cauliflower. Different nutrient package significantly influence the yield and yield components of cabbage and cauliflower. Highest head yield of cabbage (93.65 t/ha) & curd yield of cauliflower (53.77 t/ha) were obtained from T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer) which was close to T_3 treatment (5 t CD slurry with IPNS base inorganic fertilizer) (Head yield of cabbage = 89.16 t/ha; curd yield of cauliflower = 49.56 t/ha). Nutrient uptake was higher in both organic and inorganic fertilizer treated plot compared to no fertilizer treated plot. However, the treatment where poultry slurry was used showed higher yield and higher economic performance. Both gross margin and MBCR were higher where both organic & inorganic fertilizer were incorporated to soil compared to only inorganic fertilizer (T_1 treatment). If 3 t/ha PM slurry is applied it could save 56 kg urea/ha and 37 kg MOP/ha for cabbage. Fertilizer crisis is a burning issue across the country. Use of bio-slurry can play a vital role to minimize the fertilizer crisis. Moreover as organic manure bio-slurry may help soil fertility in the long run.

Introduction

The gradual degradation of soil fertility status of Bangladesh is now becoming a critical issue. A good soil should have at least 2.5% organic matter, but in Bangladesh most of the soils have less than 1.5%, and some soils even less than 1% organic matter (BARC, 2005). Maintenance of organic matter is a burning issue both for the farmers and agricultural scientists. Recycling of organic matter is essential for maintaining soil fertility. It is agreed that the organic sources of nutrients applied to

preceding crop can benefit the succeeding crop (Singh *et al.*, 1996 and Hedge, 1998) and the system productivity becomes sustainable through integrated use of organic and inorganic sources of nutrients (Singh and Yadav, 1992). Recently, Govt. and different NGO established biogas plant in different parts of the country. Bio-slurry can be used as an excellent organic fertilizer. The bi-product of the biogas plant i.e. bio-slurry can be used as an excellent organic fertilizer to reduce the use of chemical fertilizer. Research work and data on the bio-slurry is meager in our country.

Vegetable are grown in irrigated areas and its intensity of cultivation is more than cereal production. Cabbage and cauliflower are the important vegetables of Gazipur area. About 2000 hectors of land of Gazipur area are under cabbage and cauliflower cultivation. There is an ample scope to use bio-slurry as organic manure in cabbage and cauliflower.

Objectives :

1. To find out the effect of bio-slurry on the yield and nutrient content of cabbage and cauliflower.
2. To find out the requirement of cowdung, poultry manure & their slurry and chemical fertilizer on the yield and yield components of cabbage and cauliflower.

Materials and Methods

Two separate experiments were conducted under irrigation condition during the rabi season of 2007-08 at BARI central farm under AEZ 28 (Madhupur Tract). The chemical properties of initial soils of experimental fields were given below :

Table 5. Chemical properties of initial soil of experimental field of cabbage and cauliflower

Field	pH	OM %	Total N %	Ca	Mg	K	P	S	B	Cu	Fe	Mn	Zn
				meq/100g			µg g^{-1}						
Cabbage	5.4	1.18	0.060	3.6	1.8	0.19	13	13	0.20	6	132	47	2.00
Cauliflower	5.2	1.14	0.055	3.4	1.6	0.18	14	12	0.21	5	126	41	2.10
Critical level	-	-	-	2.0	0.8	0.20	14	14	0.20	1	10	5	2.00

Six treatments each was replicated three times in a randomized complete block design. Treatments used were as follows :

T_1: Soil test based (STB) inorganic fertilizer for high yield goal

T_2: Integrated Plant Nutrient System (IPNS) with 5 t/ha cowdung for high yield goal

T_3: Integrated Plant Nutrient System (IPNS) with 5 t/ha cowdung slurry for high yield goal

T_4: Integrated Plant Nutrient System (IPNS) with 3 t/ha poultry manure for high yield goal

T_5: Integrated Plant Nutrient System (IPNS) with 3 t/ha poultry slurry for high yield goal

T_6: Native fertility (no fertilizer used)

The rate of manure and nutrients used in different treatments are given below :

Crops	Treatment	Nutrient (kg/ha)								
		N	P	K	S	B	CD	CD slurry	PM	PM slurry
Cabbage	T_1	**200**	**79**	**88**	**23**	**1**	0	0	0	0
	T_2	180	69	73	20	1	5000	0	0	0
	T_3	176	66	71	19	1	0	5000	0	0
	T_4	178	68	72	19	1	0	0	3000	0
	T_5	174	65	69	18	1	0	0	0	3000
	T_6	0	0	0	0	0	0	0	0	0
Cauliflower	T_1	**136**	**73**	**80**	**19**	**1**	0	0	0	0
	T_2	116	63	65	16	1	5000	0	0	0
	T_3	112	60	63	15	1	0	5000	0	0
	T_4	114	62	64	15	1	0	0	3000	0
	T_5	110	59	61	14	1	0	0	0	3000
	T_6	0	0	0	0	0	0	0	0	0

There were 18 plots having an area of 6.0m x 5.0m each. Equal sized, healthy cabbage and cauliflower seedlings of 25 days were transplanted on 27th November and 29th November, 2007 in the fields. Cabbage (var. Atlas-70) and cauliflower (var. Snow White) were transplanted with a spacing of 60 cm from line to line and 45 cm from plant to plant. Fertilizers were applied as per treatment based on soil analysis and BARC fertilizer recommendation guide 2005. Urea, TSP, MP, Gypsum and Boric acid were used as a source of N, P, K, S and B, respectively. All P, K, S, B, cowdung, poultry manure and their slurry and 1/3 N were applied at the time of final land preparation and the remaining $^2/_3$ N was applied in two equal installments at 20 and 45 days after planting. The cowdung, poultry manure and their slurry used in this experiment were also analyzed and data are presented in Table 6a & 6b. All intercultural operations such as weeding, irrigation etc. were done as and when necessary to raise a healthy crop.

Table 6a. pH, % moisture and concentration of primary nutrients of the poultry manure and cowdung and their slurry used in the experimental field

Organic manure	pH	% moisture	N	P	K	C : N Ratio
			%			
Cowdung	7.48	12.28	1.03	0.53	0.75	20 : 1
Cowdung slurry	7.63	11.09	1.20	0.63	0.85	18 : 1
Poultry manure	7.76	12.14	1.80	0.95	1.35	19 : 1
Poultry slurry	7.89	10.22	2.15	1.20	1.55	16 : 1

Table 6b. Secondary nutrient and heavy metal status of the poultry manure & cowdung and their slurry used in the experimental field

Organic manure	Ca	Mg	S	As	Pb	Cd
	%			$\mu g\ g^{-1}$		
Cowdung	0.32	0.28	0.15	1.26	2.86	2.65
Cowdung slurry	0.45	0.33	0.23	1.21	2.58	2.47
Poultry manure	2.50	0.75	0.35	1.52	3.58	2.94
Poultry manure slurry	2.95	0.88	0.45	1.32	3.33	2.77

Harvesting was done from 20th February to 16th March, 2008. Five plants from each plot were tagged at random to take records on plant height, circumference and number of leaves/plant. The yield and yield attributes data were analyzed statistically and the mean differences were tested by Duncan's Multiple Range Test (Steel and Torrie, 1960).

Results and Discussion

Cabbage

The effect of different management packages of fertilizers (organic and inorganic) on the yield and yield parameters of cabbage is given in Table 7.

Head yield and yield attributes like plant height, no. of unfold leaves/plant, circumference, whole plant weight and marketable weight were significantly influenced by different nutrient packages. Application of fertilizers following IPNS approach gave higher head yield of cabbage compared to use of only inorganic fertilizers. Highest head yield (93.65 t/ha) was obtained from T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer) which was followed by T_3 treatment (5 t CD slurry with IPNS base inorganic fertilizer), T_4 treatment (3 t PM with IPNS base inorganic fertilizer) and T_2 treatment (5 t CD with IPNS base inorganic fertilizer). About 394% yield increase over native fertility (T_6) was recorded in T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer). Yield increase due to application of 5 t CD slurry with IPNS base inorganic fertilizer (T_3 treatment) was 371%. Jayakumar and Elangovan (1993) found that biogas slurry @ 300 g pot^{-1} produced the largest head of Sun flower. Application of biogas slurry increased cob yield of maize were reported by Manna and Hazra (1996). Among the 4 organic manure, PM slurry was found best for cabbage production and soil health followed by PM, CD slurry and CD. Batsai *et al*. (1979) reported that chemical fertilizer along with organic manure produced the highest cabbage yields.

Highest plant height (48.8 cm) was obtained from 3 t PM slurry with IPNS base inorganic fertilizer (T_5) which was statistically similar to 5 t CD slurry with IPNS base inorganic fertilizer (T_3) (45.6 cm) and superior to all other treatment. Lowest plant height (19.6 cm) was obtained from native fertility (T_6) treatment. Reversely, highest number of unfold leaves/plant was obtained from native fertility (T_6) treatment. Application of PM & CD and their slurry was found to have significant influence in reducing unfolded leaves. Lowest number of unfold leaves/plant (10.2) was recorded in T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer) which was close to T_3 treatment (5 t CD slurry with IPNS base inorganic fertilizer) (10.4). Like plant height, highest number of circumference (78.3 cm) and whole plant weight (3.42 kg) was obtained from T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer) which was close to T_3 treatment (Circumference = 75.9 cm & whole plant weight = 3.19 kg). The lowest circumference (34.33 cm) & whole plant weight (1.03 kg) was recorded in T_6 treatment (native fertility). Similarly, highest marketable weight (2.93 kg) was

obtained from T_5 treatment which was statistically similar to T_1, T_2, T_3 & T_4 treatment. Lowest marketable weight (0.68 kg) was recorded in T_6 (native fertility) treatment.

Table 7. Effect of different nutrient package on the yield and yield components of Cabbage

Treatment	Plant height (cm)	No. of unfold leaves/ plant	Circum-ference (cm)	Whole plant weight (kg)	Marketable weight (kg)	Head Yield (t/ha)	% increase of head yield over	
							Control	Only inorganic fertilizer
T_1	39.90c	11.60a	66.50c	2.92a	2.58a	82.74b	337	-
T_2	40.80c	11.30a	70.80bc	3.03a	2.64a	84.06ab	344	1.60
T_3	45.60ab	10.40a	75.90ab	3.19a	2.79a	89.16ab	371	7.76
T_4	43.70bc	10.90a	72.60abc	3.11a	2.71a	86.78ab	358	4.88
T_5	48.80a	10.20a	78.30a	3.42a	2.93a	93.65a	394	13.19
T_6	19.60d	14.50b	34.33d	1.03b	0.68b	18.94c	-	-
SE(±)	1.45	1.61	1.92	0.153	0.110	2.95	-	-
CV %	6.34	7.66	5.00	9.49	7.97	6.74	-	-

T_1 : STB basis inorganic fertilizer, T_2 : IPNS with 5 t/ha Cowdung,
T_3 : IPNS with 5 t/ha Cowdung slurry, T_4 : IPNS with 3 t/ha Poultry Manure,
T_5 : IPNS with 3 t/ha Poultry Manure slurry, T_6 : Native fertility (control)

Cauliflower

The effect of different management packages of fertilizers (organic and inorganic) on the yield and yield parameters of cauliflower was given in Table 8.

Different nutrient package significantly influenced curd yield and yield components like plant height, no. of leaves/plant, circumference, whole plant weight and marketable weight. Application of fertilizers following IPNS approach gave higher curd yield of cauliflower compared to use of only inorganic fertilizers. Highest curd yield (53.77 t/ha) was obtained from T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer) which was statistically similar to T_3 treatment (5 t CD slurry with IPNS base inorganic fertilizer) (49.56 t/ha). These yield followed by T_4 treatment (3 t PM with IPNS base inorganic fertilizer) and T_2 treatment (5 t CD with IPNS base inorganic fertilizer). About 323% yield increase over native fertility (T_6) was recorded in T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer). Yield increase due to application of 5 t CD slurry with IPNS base inorganic fertilizer (T_5 treatment) was 306%. Jayakumar and Elangovan (1993) found that biogas slurry @ 300 g pot^{-1} produced the largest head of Sunflower. Application of biogas slurry increased cob yield of maize was reported by Manna and Hazra (1996). Among the 4 organic manure, PM slurry was found best for cabbage production and soil health followed by PM, CD slurry and CD. Batsai *et al*. (1979) reported that chemical fertilizer along with organic manure produced the highest cabbage yields.

Highest plant height (50.9 cm) was obtained from 3 t PM slurry with IPNS base inorganic fertilizer (T_5) which was statistically similar to 5 t CD slurry with IPNS base inorganic fertilizer (T_3) (48.8 cm) and superior to all other treatment. Lowest plant height (25.3 cm) was obtained from native

fertility (T_6) treatment. Similarly, highest number of leaves/plant (19.3 cm) was obtained from 3 t PM slurry with IPNS base inorganic fertilizer (T_5) which was statistically similar to T_2, T_3 & T_4 treatment. These treatment consist of both organic and inorganic fertilizer. Lowest number of leaves/plant (11.6) was recorded in T_6 treatment (native fertility). Like plant height, highest number of circumference (56.66 cm) was obtained from T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer) which was similar to T_3 treatment (53.03 cm) and superior to all other treatment. The lowest circumference (23.16 cm) was recorded in T_6 treatment (native fertility). Application of PM & CD and their slurry was found to have significant influence in increasing circumference. The whole plant weight (2.17 kg) was highest in T_5 treatment (3 t PM slurry with IPNS base inorganic fertilizer) which was close to T_3 treatment (5 t CD slurry with IPNS base inorganic fertilizer) (2.14 t/ha). These plant weight were higher those weights obtained from decomposed cowdung (T_2) & poultry manure (T_4) treatment. Lowest whole plant weight (0.56 kg) was recorded from T_6 treatment. Highest marketable weight (1.72 kg) was obtained from T_5 treatment which was statistically similar to T_2, T_3 & T_4 treatment. These weight were obtained from application of both organic and inorganic fertilizer. These marketable weight are superior to inorganic fertilizer treated plot (1.50 kg). Lowest marketable weight (0.33 kg) was recorded in T_6 (native fertility) treatment.

Table 8. Effect of different nutrient package on the yield and yield components of cauliflower

Treatment	Plant height (cm)	No. of leaves/ plant	Circum-ference (cm)	Whole plant weight (kg)	Marketable weight (kg)	Curd yield (t/ha)	% increase of curd yield over	
							Control	Only inorganic fertilizer
T_1	44.40b	18.08a	45.96c	1.96a	1.50b	42.97c	238	-
T_2	45.90b	18.37a	48.83bc	2.01a	1.58ab	44.36c	249	3.23
T_3	48.80ab	18.95a	53.03ab	2.14a	1.66ab	49.56ab	306	15.34
T_4	46.70ab	18.68a	50.55bc	2.06a	1.61ab	46.94bc	290	9.24
T_5	50.90a	19.30a	56.66a	2.17a	1.72a	53.77a	323	25.13
T_6	25.30c	11.60b	23.16d	0.56b	0.33c	12.70d	-	-
SE(±)	1.43	0.86	1.55	0.068	0.052	1.45	-	-
CV %	5.66	8.52	5.78	6.40	6.42	6.02	-	-

T_1 : STB basis inorganic fertilizer, T_2 : IPNS with 5 t/ha Cowdung,
T_3 : IPNS with 5 t/ha Cowdung slurry, T_4 : IPNS with 3 t/ha Poultry Manure,
T_5 : IPNS with 3 t/ha Poultry Manure slurry, T_6 : Native fertility (control)

PM slurry and CD slurry exhibited better response than PM & CD on yield and different yield attributes (circumference, no. of unfolded leaves) at both the levels and combinations. It may be attributed to the release of nitrogen, the first limiting essential nutrient, which is readily available to the plants through poultry manure. Smith (1950) reported that uric acid, which constituted 60 per cent of the nitrogen in poultry manure, changes rapidly to ammoniacal form which is utilized by the plants. Another important factor contributing to the higher yield with PM might be their higher N content or increased availability of native soil nitrogen through increased biological activity. The field under experiment was poor in N content. Brown (1958) observed that PM contained growth promoting hormones which produced better root growth.

Picture 1. Global Biogas Practice Leader Wim van nes accompanied with IDCOL and BARI personnel visiting the experimental field

Picture 2. IDCOL personnel and scientists of BARI visiting the experimental field

Nutrient concentration and uptake

Cabbage

Nutrient concentration of cabbage root was higher thant that of cabbage leaf (Table 9). Nutrient concentration of cabbage root ranges from 0.98 to 1.40% (N), 0.30 to 0.42% (P), 1.62 to 2.22% (K), 0.24 to 0.37% (S) and 0.0010 to 0.0018% (B). Similarely nutrient concentration of cabbage leaf ranges from 0.144 to 0.156% (N), 0.053 to 0.058% (P), 0.185 to 0.205% (K), 0.036 to 0.042% (S) and 0.0039 to 0.0056% B). The nutrient uptake was higher in T_5 treatment (IPNS with 3 t PM slurry/ha) followed by T_3 (IPNS with 5 t CD slurry/ha), T_4 (IPNS with 3 t PM/ha), T_2 (IPNS with 5 t CD/ha) and T_1 (Soil test based inorganic fertilizer), which attributed to the yield of respective treatments (Table 5). The lowest nutrient uptake was recorded in T_6 treatment (Native fertility) which is due to lowest yield.

Table 9. Effect of different nutrient packages on nutrient concentration and nutrient uptake of cabbage

Treat ment	Root concentration (%)					Leaf concentration (%)					Total uptake (kg ha^{-1})				
	N	P	K	S	B	N	P	K	S	B	N	P	K	S	B
T_1	1.12	0.36	1.68	0.27	0.0016	0.153	0.057	0.199	0.041	0.0051	126	47	164	33	4.20
T_2	1.12	0.30	1.62	0.28	0.0014	0.147	0.054	0.190	0.039	0.0046	124	46	160	33	3.87
T_3	0.98	0.37	1.92	0.37	0.0018	0.146	0.053	0.188	0.038	0.0044	130	47	168	34	3.92
T_4	0.98	0.42	2.22	0.35	0.0011	0.145	0.054	0.187	0.036	0.0041	126	47	162	31	3.55
T_5	1.40	0.36	2.10	0.31	0.0016	0.144	0.053	0.185	0.037	0.0039	135	49	173	34	3.65
T_6	0.98	0.33	1.98	0.24	0.0010	0.156	0.058	0.205	0.042	0.0056	30	11	39	8	1.06

Cauliflower

Nutrient concentration of cauliflower leaf ranges from 0.151 to 0.161% (N), 0.056 to 0.065% (P), 0.137 to 0.147% (K), 0.046 to 0.056% (S) and 0.0043 to 0.0066% (B). Similarly nutrient concentration of cauliflower curd ranges from 0.142 to 0.151% (N), 0.064 to 0.072% (P), 0.171 to 0.183% (K), 0.034 to 0.040% (S) and 0.0046 to 0.0069% B). The nutrient uptake was higher in T_5 treatment (IPNS with 3 t PM slurry/ha) followed by T_5 (IPNS with 5 t CD slurry/ha), T_4 (IPNS with 3 t PM/ha), T_2 (IPNS with 5 t CD/ha) and T_1 (Soil test based inorganic fertilizer), which attributed to the yield of respective treatments (Table 10). The lowest nutrient uptake was recorded in T_6 treatment (Native fertility) which is due to lowest yield.

Table 10. Effect of different nutrient packages on nutrient concentration and nutrient uptake of cauliflower

Treatment	Leaf concentration (%)					Curd concentration (%)					Total uptake (kg ha^{-1})				
	N	P	K	S	B	N	P	K	S	B	N	P	K	S	B
T_1	0.158	0.063	0.144	0.053	0.0057	0.148	0.071	0.180	0.038	0.0063	101	45	111	29	4.05
T_2	0.155	0.059	0.139	0.050	0.0050	0.145	0.067	0.174	0.036	0.0055	101	44	111	28	3.64
T_3	0.153	0.058	0.138	0.048	0.0047	0.144	0.066	0.173	0.035	0.0052	110	47	120	30	3.76
T_4	0.152	0.058	0.138	0.048	0.0046	0.143	0.066	0.172	0.034	0.0050	104	45	114	28	3.47
T_5	0.151	0.056	0.137	0.046	0.0043	0.142	0.064	0.171	0.034	0.0046	115	49	127	30	3.58
T_6	0.161	0.065	0.147	0.056	0.0066	0.151	0.072	0.183	0.040	0.0069	39	17	41	12	1.68

Cost and return analysis

Cabbage

The highest gross margin (Tk. 4,50,378/ha) was obtained from the treatment T_5 (3 t PM slurry/ha with IPNS basis inorganic fertilizer). The highest MBCR value (35.03) was obtained from 3 t PM/ha with IPNS basis inorganic fertilizer (T_4 treatment) because of low price of poultry manure. Both gross margin and MBCR were higher when organic and inorganic fertilizer were applied following IPNS approach compared to only inorganic fertilizer (T_1 treatment).

Table 11. Cost and return analysis of cabbage as affected by different treatments

Treatment	Head yield of cabbage (t/ha)	Gross return (Tk./ha)	Variable cost (Tk./ha)	Gross margin (Tk./ha)	Marginal gross margin (Tk./ha)	Marginal variable cost (Tk./ha)	MBCR
T_1	82.74	4,13,700	12,096	4,00,794	3,06,094	12,096	25.31
T_2	84.06	4,20,300	10,277	4,10,023	3,15,323	10,277	30.68
T_3	89.16	4,45,800	20,949	4,27,851	3,35,151	20,949	16.00
T_4	86.78	4,33,900	9,443	4,27,457	3,30,757	9,443	35.03
T_5	93.65	4,68,250	17,872	4,50,378	3,55,678	17,874	19.90
T_6	18.94	94,700	0	94,700	-	-	-

Price (Tk./kg): N = 13.04, P = 80.00, K= 32.00, S= 22.22, B= 352.94, Cowdung = 0.75, Poultry Manure= 1.00
CD slurry = 3.00, PM slurry = 4.00, cabbage= 5.00, cauliflower= 6.00

Cauliflower

The highest gross margin (3,06,407/ha) was obtained from 3 t PM slurry/ha with IPNS basis inorganic fertilizer (Treatment T_5). The highest MBCR value (25.65) was obtained from 3 t PM/ha with IPNS basis inorganic fertilizer (T_4 treatment) because of low price of poultry manure. Both gross margin and MBCR were higher where organic and inorganic fertilizer were incorporated to soil compared to only inorganic fertilizer (T_1 treatment).

Table 12. Cost and return analysis of cauliflower as affected by different treatments

Treatment	Curd yield of cauliflower (t/ha)	Gross return (Tk./ha)	Variable cost (Tk./ha)	Gross margin (Tk./ha)	Marginal gross margin (Tk./ha)	Marginal variable cost (Tk./ha)	MBCR
T_1	42.97	2,57,820	10,771	2,47,049	1,76,849	10,771	16.42
T_2	44.36	2,66,160	8,618	2,57,542	1,81,342	8,618	21.04
T_3	49.56	2,97,360	19,297	2,76,063	1,99,863	19,297	10.36
T_4	46.94	2,81,640	7,784	2,75,856	1,99,656	7,784	25.65
T_5	55.77	3,22,620	16,213	3,06,407	2,30,207	16,213	14.20
T_6	12.70	76,200	0	76,200	-	0	-

4.2.3 On-Farm trials

The status of on-farm trials is given in Table 13.

Table 13. Status of on-farm trials

Planned			Executed		
No. of experiment.	No. of crops	No. of sites	No. of experiment.	No. of crops	No. of sites
01	09	25	01	07	20

The trials planed with Brinjal was not conducted and Jute was yet in field.

EFFECT OF BIO-SLURRY AS A SOURCE OF ORGANIC MANURE ON PERFORMANCE OF DIFFERENT CROPS

Abstract

Field experiments were conducted at different locations (Pabna, Jessore, Rangpur, Tangail, Gazipur, Comilla, Bogra, Mymensingh and Faridpur) to observe the effect of bio-slurry on the performance of different crops (Tomato, Cabbage, Cauliflower, Potato, Maize, Boro rice and Wheat) during 2007-08. Four nutrient management options viz. inorganic fertilizer, IPNS with cowdung/poultry manure, IPNS with cowdung slurry/poultry slurry and farmers' management along with native fertility were tested on the crops. The yield of the crops was significantly influenced by the different nutrient management options. A positive response of slurry was found on the crops. Higher yield of tomato in Pabna, Jessore and Rangpur, higher cabbage yield in Gazipur, Tangail and Jessore, higher yield of cauliflower in Gazipur and Tangail, higher yield of potato in Rangpur, higher grain yield of Boro rice in Mymensingh and higher yield of maize was found in Pabna and Rangpur. Higher economic return was recorded from slurry in most cases.

Introduction

Depletion of soil organic matter is a major constraint for higher crop productivity in Bangladesh. A good soil should have an organic matter content of at least 2.5% (FRG, 2005). But in Bangladesh, most soils have less than 1.7%, and some soils have even less than 1% organic matter. The average organic matter content of top soils has decline by 20-46% over past 20 years due to intensive cropping without inclusion of legume crops, imbalance use of fertilizer, use of modern varieties and scanty use of manure. So gradually degradation of soil fertility status of the country is now becoming a critical issue. Bhuiyan (1991) reported yield of several crops are declining in some soils. So the maintenance of organic matter is a burning issue both for the farmers and agricultural scientists. Biogas is going to be popular in Bangladesh due to high cost of fuel. Huge amount of bio-slurry may come out from this plant and it can be used as an excellent organic fertilizer. Bio-slurry improved the physical and biological quality of soil besides providing both macro and micro-nutrients to crops. These improve in water holding capacity, cation exchange capacity, lesser soil erosion and provision of nutrients to plants and soil micro-flora including N fixing and phosphorous solubilzing organisms. In addition, bio-slurry is free of weed seeds.

Balanced fertilization is a prerequisite for exploiting optimum yield potentials of high yielding crops. The beneficial effect of organic manure in crop production has been demonstrated by many workers (Joshi *et. al.*, 1994; Batsai *et. al.*, 1979; Singh *et. al.*, 1970 and Subhan, 1991). Research work on the bio-slurry is lacking in our country. Many crops are grown in Bangladesh. Therefore, it is very important to evaluate the effect of bio-slurry on some of the crops.

Objective : To study the effect of bio-slurry on the yield and yield components of different crops in different locations.

Materials and Methods

On-farm trials were conducted at 20 sites with 7 crops (Table 14) during the rabi season of 2007-2008. The experiment was laid out in RCB design with three compact replications and the same trial was conducted in three farmers' field at each site. Unit plot size was 8m x 5m. Five nutrient management options viz.-T_1: Soil test based (STB) inorganic fertilizer for high yield goal, T_2: Nutrient management following integrated plant nutrition system (IPNS) approach (with cowdung or poultry manure) for high yield goal, T_3: Nutrient management following integrated plant nutrition system approach (with cowdung or poultry slurry) for high yield, T_4: Farmers dose and T_5: Native fertility (no fertilizer used) were verified. The detailed of treatments are presented in Table 15. Soil test value and management practices of the different locations is presented in the Appendix Table 1 and Appendix Table 2, respectively.

Table 14. Different crops tested in different locations

Crops	Location
Tomato	Pabna, Jessore and Rangpur
Cabbage	Gazipur, Tangail, Pabna and Jessore
Cauliflower	Gazipur, Tangail, Pabna,
Potato	Comilla, Rangpur and Joypurhat
Maize	Pabna and Rangpur
Boro rice	Pabna, Mymensingh, Tangail
Wheat	Faridpur and Rangpur

Table 15. Nutrient dose (kg/ha) of treatments applied in different crops tested in different locations

Treatment	Crop : Tomato (N-P-K-S-Zn-B + CD/PM manure or CD/PM slurry)		
	Pabna	Rangpur (cowdung based)	Rangpur (poultry based)
T_1	107-34-31-11-2-0.4	150-40-140-30-4-1	150-40-140-30-4-1
T_2	90-30-20-11-2-0.4+3000 PM	144-38-138-30-4-1+5000 CD	144-38-138-30-4-1+3000 PM
T_3	90-30-20-11-2-0.4+3000 PS	137-33-115-30-4-1+5000 CDS	115-33 -119-30-4-1+3000 PS
T_4	173-72-90-32-12-2.3	101-34-62-9+2000CD	101-34-62-9+2000 CD
T_5	0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0-0

Treatment	Crop : Cabbage (N-P-K-S-Zn-B + CD/PM manure or CD/PM slurry)		
	Gazipur	Tangail	Pabna
T_1	218-12-137-31-1	74-8-40-5-0.5	161-98-25-23-4-0.53
T_2	186-12-116-31-1+ 3000 PM	53-6-25-3-0.37+ 5000 CD	146-93-10-23-4-0.53+3000 CD
T_3	181-12-116-31-1 + 3000 PS	53-6-25-3-0.37+ 5000 CDS	139-91-0-23-4-0.53+3000 CDS
T_4	98-62-47-19-0 + 8000 CD	42-4-15-2-0.3	242-72-90-32-12-2.3
T_5	0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0-0

Treatment	Crop : Cauliflower (N-P-K-S-Zn-B + CD/PM manure or CD/PM slurry)		
	Gazipur	Tangail	Pabna
T_1	163-12-102-24-1	74-10-30-5-0.57	107-56-49-18-3-0.4
T_2	133-12-81-24-1+ 3000 PM	67-7-21-3-0.4 + 5000 CD	77-37-28-18-3-0.4 + 3000 PM
T_3	128-12-81-24-1+ 3000 PS	67-7-21-3-0.4 + 5000 CDS	73-25-28-18-3-0.4 + 3000 PS
T_4	98-62-47-19-0+ 8000 CD	46-4-15-2-0.3	242-72-90-32-12-2.3
T_5	0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0-0

Treat-ment	Crop : Potato (N-P-K-S-Zn-B + CD/PM manure or CD/PM slurry)			
	Comilla	Rangpur (Cowdung based)	Rangpur (Poultry manure based)	Joypurhat
T_1	128-26-120-14-3-1	135-25-140-17-3-1.5	135-25-140-17--3-1.5	150-23-144-15-2.5-1
T_2	120-25-110-13-3-1 + 5000 CD	129-20-132-17--3-1.5 +5000	129-23-138-17--3-1.5+3000	122-20-138-15-2-1+5000 CD
T_3	118-25-107-13-3-1+5000 CDS	112-18-115-17-3-1.5+5000	100-20-119-17-3-1.5+3000	121-20-136-15-2-1+5000 CDS
T_4	200-75-115-0-0-0 + 10000 CD	110-48-160-20-4-1+7500	110-48-160-20-4-1+7500	153-47-105-15-0-0+5000 CD
T_5	0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0-0

Treatment	Crop : Maize (N-P-K-S-Zn-B + CD/PM manure or CD/PM slurry)		
	Pabna	Rangpur (Cowdung based)	Rangpur (Poutry based)
T_1	189-32-40-29-1-1	220-18-37-12-5-2	220-18-37-12-5-2
T_2	159-23-29-29-1-1 + 3000 PM	211-13-29-12-5-2+ 5000 CD	214-16-35-12-2-2+ 3000 PM
T_3	155-23-29-29-1-1 + 3000 PS	198-11-12-12-5-2+ 5000 CDS	186-16-35-12-5-2+ 3000PS
T_4	136-23-38-21-3	104-19-65-11-3-1	104-19-65-11-3-1
T_5	0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0-0

Treatment	Crop : Boro rice (N-P-K-S-Zn-B + CD manure/CD slurry)		
	Pabna	Mymensingh	Tangail
T_1	144-26-25-4-2	156-24-144-26	120-15-40-10-0-1
T_2	129-21-20-4-2+ 5000 CD	141-18-127-26 + 5000CD	105-10-25-10-0-1 + 5000CD
T_3	121-20-20-.4-2+ 5000 CDS	137-17-119-26 + 5000 CDS	98-8-15-10-0-1+ 5000 CDS
T_4	103-14.2-30-11.3-2.7	134-21-40-7	154-31-52
T_5	0-0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0

Treatment	Crop : Wheat (N-P-K-S-Zn-B + CD/PM manure or CD/PM slurry)		
	Faridpur	Rangpur (Cowdung based)	Rangpur (Poutry based)
T_1	100-35-50-10-1	130-20-80-30-4-1.5	130-20-80-30-4-1.5
T_2	80-30-40-10-2 + 3000 PM	124-15-72-24--41.5 + 5000 CD	124-18-78-30-4-1.5+ 3000 PM
T_3	80-30-30-10-2 + 3000 PS	108-13-55-30-41.5 + 5000 CDS	96-18-69-30-4-1.5 + 3000 PS
T_4	105-21-26-14	70-23-32-12-0-0.7	70-23-32-12-0-0.7
T_5	0-0-0-0-0-0-0	0-0-0-0-0-0	0-0-0-0-0-0

PM = Poultry manure, PS = Poultry slurry, CD = Cowdung, CDS = Cowdung slurry

Results and Discussions

Crop: Tomato

Location: MLT site, Pakshi, Pabna

Although higher tomato yield was attained in IPNS with poultry slurry (T_3) but it was statistically imilar with IPNS with 3t/ha poultry manure (T_2) (Table 16). The yield from poultry slurry treated plot was 12% and 7% higher than that of only inorganic fertilizer (T_1) and IPNS with poultry manure treatment, respectively. Higher gross margin and MBCR were obtained from IPNS with 3 t/ha poultry slurry (T_3) due to higher gross return and less variable cost.

Table 16. Yield, cost and return analysis of Tomato as influenced by different nutrient management options at the MLT site, Pakshi, Pabna during 2007-08

Treatments	Fruit yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility)
T_1 = STB inorganic fertilizer for HYG	44.47c	266820	10359	256461	16.68
T_2 = IPNS with 3 t/ha PM	62.80ab	376800	11404	365396	24.80
T_3 = IPNS with 3 t/ha PS	66.34a	398040	10703	387337	28.41
T_4 = Farmers practice	54.03b	204180	24907	179273	4.42
T_5 = Native fertility	15.66d	93960	0	93960	-
CV(%)	9.03	-			

Price of input (Tk/kg) : Urea 6.50, TSP 28.00, MP 35.00, Gypsum 08.00, Zinc oxide 70.00, Borax 65.00, Poultry manure 1.00, Poultry slurry 1.00

Price of Tomato TK. 6.00/kg

Location: Jessore sadar

The yield of tomato slurry treated plot was found superior than that of cowdung manure. The highest yield (74.87 t/ha) was obtained with the combination of cowdung slurry and inorganic fertilizer which was 12 and 8% higher than that of only inorganic fertilizer and IPNS with cowdung manure, respectively (Table 17). Higher gross return gross margin and MBCR were found in the same treatment (Table 17).

Table 17. Yield, cost and return analysis of Tomato as influenced by different nutrient management options at Jessore sadar during 2007-08

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility)
T_1: STB inorganic fertilizer for HYG	67.08b	402480	10372	392108	22.89
T_2 : IPNS with 5t/ha CD	69.51b	417060	11290	405770	22.32
T_3: IPNS with 5t/ha CD slurry	74.87a	449220	10700	438520	26.56
T_4: Farmers practice	62.52b	375120	24907	350213	8.43
T_5: Native fertility	27.50c	165000	0	165000	0
CV (%)	9.63				

Market Price of input (Tk/kg): Urea-6.50, TSP-30.00, MP-30.00, Gypsum-5.00, Zinc sulphate- 120.00, Boric acid-110.00 Cowdung-1.00 and cowdung slurry-1.00.

Price of tomato : Tk. 6.00/kg

Location: FSRD site, Lahirirhat, Rangpur

The efficiency of cowdung slurry was found superior than cowdung manure. Although higher yield was obtained with poultry slurry but it was similar with poultry manure (Table 18). Higher gross return and gross margin were obtained from the slurry treated plot. Due to less variable cost, higher MBCR was obtained in the farmer's practices.

Table 18: Yield, cost and return analysis of Tomato as influenced by different nutrient management options at the FSRD site, Laharirhat, Rangpur during 2007- 08

Treatment	Yield (t/ha)		Gross return(Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR (over native fertility	
	Cowdung based	Poultry Based	CD	PB	Cowdung based	Poultry Based	Cowdung based	Poultry Based	Cowdung based	Poultry Based
T_1: STB inorganic fertilizer for HYG	85.89c	78.3b	515340	469800	21320	21320	494020	448480	9.27	11.89
T_2: IPNS with CD/PM	96.83b	102.5a	580980	615000	25407	23757	555573	591243	9.31	15.79
T_3: IPNS with CD/PM slurry	104.67a	105.0a	628020	630000	23150	21158	604870	608842	13.40	19.56
T_4: Farmers practice	80.88c	67.2b	485280	403200	13818	13818	471462	389382	12.12	13.53
T_5: Native fertility	52.95d	36.2c	317700	216120	0	0	494020	216120	0	0
CV (%)	6.1	11.3								

Price of input (Tk/kg) : Urea-6.50, TSP-32.00, MP-35.00, Gypsum-5.00, Zinc sulphate- 120.00, Boric acid-110.00, Cowdung-1.00 and cowdung slurry-1.00.

Price of Tomato (Tk/kg): Tk 6.00

CD = Cowdung based, PB = Poultry based

Crop : Cabbage

Location : MLT site, Dhirashram, Gazipur

Yield did not varied significantly among the nutrient management options. But the yield of the treatment T_3 was about 15 % higher than that of the treatment T_1, T_2 and T_4 (Table 19). Due to application of high amount of phosphorus and cowdung the variable cost was higher in farmers' dose (T_4). Gross return, gross margin and MBCR were higher in the treatment where slurry was used.

Table 19. Yield, cost and return analysis of cabbage (var. Autumn queen) as influenced by different nutrient management options at MLT site, Dhirashram, Gazipur during 2007-08

Treatment	Yield (t/ha)	Gross return (Tk./ha)	Cost of fertilizer (Tk./ha)	Gross margin (Tk./ha)	MBCR over native fertility
T_1 : Inorganic fertilizer for HYG	85.52a	342080	10133	331947	28.35
T_2 : IPNS with 3 t/ha PM	84.95a	339800	10919	328881	26.10
T_3 : IPNS with 3 t/ha PS	98.10a	392400	9507	382893	35.51
T_4: Farmers practice	84.80a	33200	12748	20452	22.31
T_5: Native fertility	13.69b	54760	0	54760	-
CV(%)	8.69				

Price of input (Tk/kg) **:** Urea 6.00, MP 19.00, TSP 19.00, Gypsum 7.00, Cowdung 1.00, Bio-slurry 1.00.,

Price of output (Tk/kg): Cabbage 4.00

Location : MLT site, Tangail sadar

Higher yield was obtained from IPNS with cowdung slurry (T_3) but it was similar with the yield of the plot treated with IPNS with cowdung (T_2) (Table 20). Higher economic benefit was recorded from the same treatment.

Table 20. Yield, cost and return analysis of cabbage (var. Autumn queen) as influenced by different nutrient management options at Tangail sadar during 2007-08

Treatments	Yield (t/ha)	Gross return (Tk./ha)	Cost of fertilizer (Tk./ha)	Gross margin (Tk./ha)	MBCR over native fertility
T_1 : Inorganic fertilizer for HYG	72.05	288200	10178	278022	16.92
T_2 : IPNS with 5 t/ha CD manure	82.55	330200	11381	318819	18.82
T_3 : IPNS with 5 t/ha CD slurry	87.77	351080	11382	339698	20.65
T_4: Farmers practice	54.17	216680	8579	208101	11.74
T_5: Native fertility	29.00	116000	0	116000	-
LSD (0.05)	7.07			-	-
CV (%)	5.8			-	-

Price of input (Tk/kg): Urea 6.00, MP 35.00, TSP 40.00, Gypsum 7.00, Cowdung 1.00, Bio-slurry 1.00

Price of output (Tk/kg): 4.00

Location : MLT site, Pakshi, Pabna

Significant yield variation was found in between the inorganic and the combination of inorganic and cowdung manure (IPNS). Although slurry did not show superiority over the inorganic and IPNS with cowdung but the MBCR from slurry treatment was closer due to less fertilizer cost (Table 21).

Picture 3. IDCOL personnel & CSO, OFRD visiting the Experimental plots at Gazipur

Picture 4. Cabbage produced from without fertilizer (left) and with poultry bioslurry (right)

Table 21. Yield, cost and return analysis of cabbage (var. Autumn queen) as influenced by different nutrient management options at the MLT site, Pakshi, Pabna during 2007- 08

Treatments	Head yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility
T_1 : Inorganic fertilizer for HYG	119.90a	359700	14799	344901	17.41
T_2 : IPNS with 5 t/ha CD manure	120.31a	360930	15011	345919	17.24
T_3 : IPNS with 5 t/ha CD slurry	111.93b	335790	13001	322789	17.94
T_4: Farmers practice	111.34b	334020	25617	77850	9.05
T_5: Native fertility	34.07c	102210	0	102210	-

Price of input (Tk/kg) : Urea 6.50, TSP 28.00, MP 35.00, Gypsum 08.00, Zinc oxide 70.00, Borax 65.00 Cowdung compost (CD)= 1.50, Cowdung slurry (CDS) = 1.50

Price of out put (Tk/kg) : Cabbage 3.00

Location : Jessore sadar

Cowdung slurry along with inorganic fertilizer gave significantly higher yield than that of only inorganic fertilizer. It might be due to readily available of No the plants from cowdung slurry. Due to less fertilizer cost and higher gross return, higher gross margin and higher MBCR were higher in slurry treated treatment (Table 22).

Table 22. Yield, Cost and return analysis of cabbage as influenced by different nutrient management options at Jessore during 2007-08

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility)
T_1= Inorganic fertilizer for HYG	55.73b	222920	14800	208120	8.71
T_2 =IPNS with 5 t/ha CD manure	63.78a	255120	15211	239909	10.59
T_3 = IPNS with 5 t/ha CDS	65.21a	260840	14288	246552	13.15
T_4= Farmers practice	57.55b	230200	22600	207600	6.02
T_5=Native fertility	23.50d	94000	0	94000	-
CV(%)	11.18				

Price input (tk/ha)Urea-6.50, TSP-30.00, MP-30.00, Gypsum,-5.00, Zinc sulphate- 120.00, Boric acid-110.00, Cowdung-1.00 and Cowdung slurry-1.00.

Price output (Tk/kg): Cabbage 4.00

Crop : Cauliflower

Location: MLT site, Dhirashram, Gazipur

Higher yield was obtained in the treatment T_3 where poultry slurry was used. The yield of the treatment T_3 was 16, 9 and 14% higher than that of T_1, T_2 and T_4, respectively. fertilizer cost ranges from Tk. 8604/ha to Tk. 8867/ha among the nutrient management packages (Table 23). But it was higher in the farmers' dose due to application of large amount of phosphorus and higher amount of cowdung that resulted less MBCR. Gross margin as well as MBCR was higher in the treatment T_3 where poultry slurry was used.

Table 23. Yield, cost and return analysis of cauliflower (var. Shiraziku) as influenced by different nutrient management options at MLT site, Dhriasram, Gazipur during 2007-08

Treatment	Yield (t/ha)	Gross return (Tk./ha)	Fertilizer cost (Tk./ha)	Gross margin (Tk./ha)	MBCR over native fertility
T_1 : Inorganic fertilizer for HYG	59.66ab	357960	8604	349356	31.14
T_2 : IPNS with 3 t/ha PM	63.32ab	379920	8932	370988	32.46
T_3 : IPNS with 3 t/ha PS	69.24a	415440	8867	406573	36.70
T_4: Farmers practice	60.77b	364620	13609	351011	20.18
T_5: Native fertility	15.00c	90000	0	90000	-
CV(%)	10.11	-	-		

Price of input (Tk/kg) **:** Urea 6.00, MP 19.00, TSP 19.00, Gypsum 7.00, Cowdung 1.00, Bio-slurry 1.00,
Price of output (Tk./kg) : Cauliflower 6.00

Location: Tangail sadar

Yield variation was not found between cowdung manure and cowdung slurry treated plots(Table 24). Higher gross return and higher gross margin were found in the slurry treated plot. Due to less fertilizer cost, higher MBCR was found in the farmers practice (10.03) but it followed by the slurry treatment (MBCR was higher in inorganic treatment due to less fertilizer cost (Table 24).

Table 24.Yield, cost and return of cauliflower as influenced by different nutrient management options at MLT site, Tangail sadar during 2007-08

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR over native fertility
T_1 : Inorganic fertilizer for HYG	38.94	233640	10454	223186	8.84
T_2 : IPNS with 5 t/ha CD manure	42.98	257880	12109	245771	9.11
T_3 : IPNS with 5 t/ha CD slurry	43.61	261660	11479	250181	10.03
T_4: Farmers practice	31.22	187320	9049	178271	10.21
T_5: Native fertility	20.94	125640	0	125640	-
LSD (0.05)	2.00	-	-	-	-
CV (%)	3.00	-	-	-	-

Price of input (Tk/kg) **:** Urea 6.00, MP 35.00, TSP 40.00, Gypsum 7.00, Cowdung 1.00, Bio-slurry 1.00,
Price of output (Tk/kg) : Cauliflower 6.00

Location : MLT site, Pakshi, Pabna

Poultry manure showed superiority over the poultry slurry regarding the yield but MBCR was higher in slurry treatment due to less fertilizer cost (Table 25).

Table 25.Yield, cost and return analysis of cauliflower influenced by different nutrient management options at the MLT site, Pakshi, Pabna during 2007-08

Treatments	Curd yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR over native fertility
T_1=Inorganic fertilizer for HYG	55.77c	278850	15823	263027	10.94
T_2 = IPNS with 3 t/ha PM	66.32a	331600	15391	316209	14.67
T_3 = IPNS with 3 t/ha PS	60.98b	304900	13412	291488	14.84
T_4 = Farmer practice	58.06c	290300	27562	262738	6.69
T_5 = Native fertility	21.16d	105800	0	105800	-
CV(%)	8.19	-			

Price of input (Tk/kg): Urea = 6.50, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax= 65.00, Poultry manure (PM)= 1.00, Poultry slurry (PS)= 1.00 Cauliflower = 5.00,
Price of output (Tk./kg) : Cauliflower 5.00

Crop : Potato

Location : Comilla sadar

There was no significant yield variation among the nutrient options. Responses of cowdung or slurry on the potato yield was not found (Table 26). Due to less fertilizer cost, higher MBCR was found in inorganic fertilizer for HYG.

Table 26. Yield, cost and return analysis of Potato (var.Cardinal) influenced by different nutrient management options at Comilla sadar during 2007-08

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR
T_1 : Inorganic fertilizer for HYG	15.20	152000	15630	136370	5.46
T_2 : IPNS with 5 t/ha CD manure	16.75	167500	22207	145293	4.54
T_3 : IPNS with 5 t/ha CD slurry	17.33	173300	21984	151316	4.85
T_4: Farmers practice	17.05	170500	37036	133464	2.81
T_5: Native fertility	6.66	66600	0	66600	-
CV (%)	11.04	-	-	-	-
LSD (5%)	2.82	-	-	-	-

Price (Tk/kg): Urea = 6.50, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax= 65.00, Poultry manure (PM)= 1.50, Poultry slurry (PS)= 1.00, Potato = 10.00,

Location: FSRD site, Lahirirhat, Rangpur

The yield of cowdung slurry treatment was 9% and poultry slurry treatment was 26% higher than cowdung manure and poultry manure. respectively. Gross return, gross margin and MBCR were higher in the slurry treated plot (Table 27).

Table 27: Yield, cost and return analysis of potato influenced by different nutrient management options at the FSRD site Laharirhat, Rangpur during 2007- 08

Treatment	Tuber yield (t/ha)		Gross return (Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR over native fertility	
	Cowdung based	Poultry Based	CDB	PB	CDB	PB	CDB	PB	CDB	PB
T_1: Inorganic fertilizer for HYG	25.74b	14.13b	257400	141300	17626	16362	239774	124938	6.04	3.76
T_2: IPNS for HYG with manure	26.64b	15.39b	266400	153900	20374	21235	246026	132665	5.33	3.49
T_3: IPNS for HYG with slurry	29.10a	19.36a	291000	193600	21701	19906	269299	173694	6.35	5.96
T_4: Farmers practice	28.89a	15.88b	288900	158800	33278	22024	255622	136776	4.08	3.59
T_5: Native fertility	15.32c	7.97c	153200	79700	0	0	153200	79700	-	-
CV(%)	6.1	6.4	-	-	-	-	-	-	-	-

Price (Tk/kg): Urea = 6.50, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax= 65.00, Poultry manure (PM)= 1.50, Poultry slurry (PS)= 1.00, Potato = 10.00,

Location: MLT site, Joypurhat

Higher yield was obtained from the farmers' practice. It might be due to application of higher dose of fertilizer. Significant yield variation was not found amoung the nutrient management options. Higher MBCR was found in the only inorganic fertilizer due to less fertilizer cost (Table 28)

Table 28: Yield, cost and return analysis of potato influenced by different nutrient management options at the MLT site, Joypurhat during 2007- 08

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR over native fertility
T_1: Inorganic fertilizer for HYG	22.76	227600	17679	209921	8.47
T_2: IPNS for HYG with manure	21.70	217000	23536	193464	5.91
T_3: IPNS for HYG with slurry	22.50	225000	23271	201729	6.33
T_4: Farmers practice	23.47	234700	24304	210396	6.46
T_5: Native fertility	7.78	77800	0	77800	-
CV (%)	6.80	-	-	-	-

Price (Tk/kg): Urea = 6.50, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax= 65.00, Poultry manure (PM)= 1.00, Poultry slurry (PS)= 1.00, Potato = 10.00,

Crop : Maize

Location : MLT site, Atghoria, Pabna

The crop performance with poultry slurry management appeared better over poultry manure probably because of readily available of different nutrients to the plants. Maximum water retention in poultry slurry probably has made the environment for easily uptake of nutrients by the crop plants (Table 29). Yield from slurry treatment was at per with inorganic fertilizer treated plot but higher, MBCR was found in slurry treated plot due the less fertilizer cost.

Table 29. Yield, cost and return analysis of maize (var. NK 40) influenced by different nutrient management options at the MLT site Atghoria, Pabna during 2007-08

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR over native fertility
T_1 : Inorganic fertilizer for HYG	8.98a	116740	12619	104121	4.53
T_2: IPNS with 3t/ha PM	8.32b	108160	12186	95974	3.99
T_3 : IPNS with 3t/ha PS	8.89a	115570	10208	105362	5.49
T_4: Farmers practice	7.76c	100880	10189	90691	4.06
T_5: Native fertility	4.58d	59540	0	59540	0
CV(%)	6.08				

Price (TK/kg) : Urea = 6.00, TSP = 32.00, MP = 35.00, Gypsum = 8.00, Zinc sulphat = 120.00, Borax = 120.00. Poultry manure = 1.50, Poultry slurry = 1.00, Maize grain = 13.00

Location: FSRD site, Lahirirhat, Rangpur

The highest grain yield was obtained from the IPNS with slurry (5t/ha cowdung slurry or 3 t/ha poultry slurry) which was 9% higher than the cowdung or poultry manure (Table 30). Higher gross margin and MBCR were recorded from slurry treatment.

Table 30. Yield, cost and return analysis of maize influenced by different nutrient management options at the FSRD site Laharirhat, Rangpur during 2007-08

Treatment	Tuber yield (t/ha)		Gross return (Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR over native fertility	
	Cowdung based	Poultry Based	CDB	PB	CDB	PB	CDB	PB	CDB	PB
T_1: Inorganic fertilizer for HYG	4.57d	5.47c	69410	71110	11626	11633	57784	59477	2.78	3.71
T_2: IPNS with manure	5.69b	6.19b	73970	80470	15143	14082	58827	66388	2.43	3.72
T_3 : IPNS with slurry	6.24a	6.76a	81120	87880	13451	13002	67669	74878	3.27	4.60
T_4: Farmers practice	5.09c	5.58c	66170	72540	10954	10954	55216	61586	2.65	4.07
T_5: Native fertility	3.85e	4.15d	37050	27950	0	0	37050	27950	0	0
CV (%)	5.0	5.4	-	-						

Price (Tk/kg): Urea = 6.00, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax= 65.00, Poultry manure (PM)= 1.50, Poultry slurry (PS)= 1.00 Maize = 13.00,

Crop: Boro rice

Location : MLT site, Atghoria, Pabna

Cowung manure showed superiority over the other nutrient management options (Table 31). Due to lower yield, gross margin and MBCR were lower in the slurry treatment.

Table 31. Yield, Cost and return analysis of Boro rice as influenced by different nutrient packages at the MLT site, Atghoria, Pabna during 2007-08

Treatments	Grain yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility)
T_1 = Inorganic fertilizer for HYG	5.95b	105868	8727	97141	5.92
T_2 = IPNS with 5 t/ha CD manure	6.28a	112685	12381	100304	4.72
T_3 = IPNS with 5 t/ha CD slurry	5.66c	99760	11884	87876	3.83
T_4: Farmers practice	5.40d	96345	7375	88970	5.71
T_5: Native fertility	2.95e	54163	0	54163	-
CV(%)	6.95				

Price of input (Tk/kg): Urea 6.00, TSP 32 .00, MP 35.00, Gypsum 8.00, Zinc oxide 120.00, Cowdung compost 1.00, Cowdung slurry 1.00

Price of out put (Tk/kg): Rice grain 16.25

Location : MLT site, Phulpur, Mymensingh

A good response of organic fertilizer (cowdung or cowdung slurry) on the yield of Boro rice was found (Table 32). Higher yield was obtained from the application of IPNS with 5t/ha cowdung slurry but it was statistically similar with the application of IPNS with 5t/ha cowdung manure. Similar found was fond in straw yield. Higher gross margin was obtained from the slurry treatment. Higher MBCR was obtained in the framers' practice due to less fertilizer cost.

Table 32. Yield, cost and return analysis of Boro rice influenced by different nutrient management options at MLT site, Phulpur, Mymensingh during 2007-08

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility)
T_1 : Inorganic fertilizer for HYG	7.43	6.73	118180	16621	101559	3.72
T_2 : IPNS with 5 t/ha CD manure	7.74	6.98	123080	19206	103874	3.47
T_3 : IPNS with 5 t/ha CD slurry	8.19	7.26	130110	18419	111691	4.00
T_4: Farmers practice	6.86	6.16	109060	8299	100761	6.35
T_5: Native fertility	3.55	3.10	56350	0	56350	-

Price of input and output: Rice grain Tk. 15.00/kg, Rice straw Tk. 1.00/kg, Urea Tk. 6.15/kg, TSP Tk. 35.00/kg, MOP Tk. 32.00/kg, Gypsum Tk. 7.00/kg, Cowdung Tk. 1.00/kg and Cowdung slurry Tk. 1.00/kg

Location : MLT site, Madhupur, Tangail

The highest yield was obtained form the farmer practice (Table 33). It might be due to application of huge amount of fertilizer. MBCR was higher in T_1 where only inorganic fertilizer was used due to lower fertilizer cost.

Table 33. Yield, cost and return analysis of Boro rice influenced by different nutrient management options at MLT site, Madhupur, Tangail during 2007-08

Treatments	Yield (t/ha)	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR (over native fertility)
T_1 : Inorganic fertilizer for HYG	6.40	104000	8133	95867	4.21
T_2: IPNS with 5t/ha CD	6.31	102537	10888	91649	3.01
T_3 : IPNS with 5t/ha CS	6.65	108062	9697	98365	3.95
T_4: Farmers practice	7.14	116025	11845	104180	3.90
T_5: Native fertility	4.29	69712	0	69712	0
CV(%)	4.8				

Price of input (Tk/kg) : Urea 6.00, USG, 6.50, TSP 40.00, MP 35.00, Gypsum 7.00, CD 1.50, Bio-slurry 1.50
Price of output (Tk/kg) : Boro rice 16.25

Crop : Wheat

Location: Badarpur, Hatgobindpur and Komorpur, Faridpur

Grain yield was not varied among the nutrient management options at Badarur and Komorpur but the higherst yield was obtained from the inorganic fertilizer in Hatgobindpur. On an average of the locations, lower yield was obtain from organic fertilizer (Table 34) due to less fertilizer cost, higher MBCR was obtained from the farmer's practice (Table 35)

Table 34: Yield of three different locations of wheat influenced by different nutrient management options in Faridpur during 2007-08

	Location			
Treatment	Badarpur	Hatgobindpur	Komorpur	Average
T_1 : Inorganic fertilizer for HYG	3.27a	3.22a	2.83	3.11
T_2: IPNS with 3t/ha PM	2.75a	2.77b	3.05	2.86
T_3 : IPNS with 3t/ha PS	2.96a	2.86b	2.94	2.92
T_4: Farmers practice	3.04a	2.76b	3.02	2.94
T_5: Native fertility	0.87b	0.71c	2.90	1.49
CV (%)	9.98	5.57	7.71	

Table 35: Average cost and return analysis of wheat influenced by different nutrient management options in Faridpur during 2007-08

Treatment	Gross return (Tk/ha)	Cost of fertilizer (Tk/ha)	Gross margin (Tk/ha)	MBCR
T_1 : Inorganic fertilizer for HYG	77750	11185	66565	3.62
T_2: IPNS with 3t/ha PM	71500	11030	60470	3.11
T_3 : IPNS with 3t/ha PS	73000	9504	63496	3.76
T_4: Farmers practice	73500	7172	66328	5.05
T_5: Native fertility	37250	0	37250	0
CV (%)				

Price of input (Tk/kg): Urea 6.00, TSP 32 .00, MP 35.00, Gypsum 8.00, Zinc oxide 120.00, Cowdung compost 1.00, Cowdung slurry 1.00

Price of out put (Tk/kg): Wheat 25.00

Location: FSRD site, Lahirirhat, Rangpur

In cowdung based, the highest yield was found in the treatment where 5t/ha cowdung slurry was used (Table 36). Yield variation was not found from cowdung manure (T_2) and the fully inorganic fertilizer (T_2). In case of poultry based, higher but similar poultry slurry and poultry manure. Higher gross margin was obtained from IPNS with slurry.

Table 36: Yield, cost and return analysis of wheat as influenced by different nutrient management options at the FSRD site Laharirhat, Rangpur during 2007-08

Treatment	Grain yield (t/ha)		Gross return (Tk/ha)		Cost of fertilizer (Tk/ha)		Gross margin (Tk/ha)		MBCR	
	Cow dung based	Poultry Based	Cow dung based	Poultry Based	Cow dung based	Poultry Based	Cow dung based	Poultry Based	Cowdung based	Poultry Based
T_1: Inorganic fertilizer for HYG	1.84b	1.65b	46000	41250	13611	12981	32389	28269	1.08	0.61
T_2: IPNS for HYG with manure	1.64bc	1.71a	41000	42750	15873	14743	25127	28007	0.61	0.64
T_3: IPNS for HYG with slurry	2.28a	1.74a	57000	43500	14499	13807	42501	29693	1.77	0.74
T_4: Farmers practice	1.53c	1.40c	38250	35000	12056	8581	26194	26419	0.58	0.14
T_5: Native fertility	1.25d	1.33d	31250	33250	0	0	31250	33250	0	0

Price (Tk/kg): Urea = 6.50, TSP = 32.00, MoP = 35.00, Gypsum = 08.00, Zinc oxide = 70.00, Borax= 65.00, Poultry manure (PM)= 1.50, Poultry slurry (PS)= 1.00 Wheat = 25.00,

Conclusion

Both anerobically decomposed cowdung bioslurry and poultry litre bioslurry have higher nutrient value than aerobically decomposed cowdung and poultry manure. Cobalt, nickel, cadmium and arsenic concentration are minimal in bioslurry. However lead toxicity were found in some poultry litter samples.

Economically profitable production of Cabbage & Cauliflower were found from PM slurry @ 3 t/ha or CD slurry @ 5 t/ha with IPNS basis inorganic fertilizer may be applied in Grey Terrace Soil (AEZ-28) of Joydebpur. Both slurry of cowdung or poultry manure were found better than decomposed cowdung or poultry manure**.**

Bio-slurry treatment of cowdung and poultry were showed better performance in terms of yield and economic point of view in most cases. In some cases higher yield was found from the framers' practice due to application of higher dose of fertilizer but it was not economically profitable. Fertilizer crisis is a burning issue not only in the country but also throughout the world. Use of bio-slurry can play a vital role to minimize the fertilizer crisis. Moreover as organic manure bio-slurry may help soil fertility in the long run. As one year experiment, it needs to repeat in the second year for further conclusion.

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Appendix Table 1. Initial soil status of the experimental site

Location	pH	O.M (%)	Total N (%)	K (m.eq./100g soil)	P	S	Zn	B
					ppm			
Mymensingh	5.22	1.14	0.11 (L)	0.048 (VL)	11.74 (L)	6.52 (VL)	2.41 (H)	
Gazipur	5.7	1.162	0.0614 (VL)	0.132 (L)	51.8 (VH)	12.2 (L)	3.04 (VH)	0.194 (L)
Pabna	7.7	2.13	0.12 (L)	0.25 (M)	9.00 (L)	13.00 (L)	0.50 (L)	0.25 (L)
Rangpur	6.03	1.25	0.06 (VL)	0.31 (M)	30.66 (VH)	33.30 (H)	0.82 (L)	0.52 (O)
Jessore	7.8	1.05	0.081(VL)	0.31 (O)	15 (M)	16 (M)	1.00 (M)	0.20 (L)
Tangail	5.9	2.60	0.137 (L)	0.14 (L)	12(M)	25(O)	4.3(VH)	0.57(O)
Bogra	4.93	0.599	0.060 (VL)	0.073(VL)	13.41(L)	7.146 (VL)	1.665(O)	-
Comilla	5.6	-	0.13 (L)	0.15 (L)	13.0 (M)	12.4 (L)	1.7 (L)	-
Faridpur	7.5	-	0.18 (M)	0.42 (H)	9.03 (L)	18.0 (M)	-	-

VL= Very low, L= Low, M= Medium, H= High, VH= Very High, O= Optimum

Appendix Table 2. Crop Management Practices

Crop	Location	Variety	Seed rate/ seedling	Time of Planting	Time of harvesting
Tomato	Pabna	Sonali	30 days	Last week of November, 2007	1st week to 3rd week of March, 2008
	Jessore	Roma VF	30 days	Last week of November, 2007	2nd week to 3rd week of March, 2008
	Rangpur	Roma VF	28 days	Last week of November, 2007	2nd week to 3rd week of March, 2008
Cabbage	Pabna	Autumn Queen	25-30 days	3rd week of November,2007	1st week of March
	Tangail	Autumn Queen	25-30 days	1st week of November	1st week of February
	Gazipur	Autumn Queen	25-30 days	3rd week of November	2nd week of February
	Jessore	Autumn Queen	25-30 days	Last week of November,2007	Last week of February,2008
Cauliflower	Tangail	Shirazuku	28 days	1st Week of November,2007	1st Week of February,2008
	Gazipur	Shirazuku	28 days	1st Week of November,2007	1st Week of February,2008
	Pabna	Shirazuku	28 days	1st Week of November,2007	1st Week of February,2008
Maize	Pabna	N. K.-40	30 kg/ha	3rd Week of November,2007	3rd Week of April ,2008
	Rangpur	Pacific -11	30 kg/ha	2nd Week of December,2007	2nd Week of May/2008
Boro Rice	Pabna	BRRI dhan-29	40-45 days	1st week of February,2008	3rd week of May,2008
	Tangail	BRRI dhan-29	40-45 days	2nd week of February,2008	3rd week of May,2008
	Mymensingh	BRRI dhan-29	40-45 days	2nd week of February,2008	3rd week of May,2008
Wheat	Rangpur	Shatabdi	120 kg/ha	3rd week of December,2007	1st week of April,2008
	Faridpur	Shatabdi	120 kg/ha	Last week of November,2007	2nd week of March,2008
Potato	Rangpur	Cardinal	1800 kg/ha	1st week of December,2007	1st week of March,2008
	Comilla	Diamant	1900 kg/ha	Last week of November,2007	1st week of March,2008
	Bogra	Cardinal	1800 kg/ha	Last week of November,2007	Last week of February,2008

5.0 Training on Bio-slurry management and utilization

Training for Scientist

A Training programme on bio-slurry management and utilization was conducted for the concerned scientists of Soil Science Division and On-Farm Research Division at BARI, Joydebpur, Gazipur on 6 November, 2007. A total of 20 participants and 6 resource speakers were attended in training course though it was planned for 15 participants and five speakers. Prospect of Biogas and Bio-slurry in Bangladesh, Management and Utilization of Bio-Slurry in crop production and Method of Bio-slurry application were discussed in the course.

Training for Cooperator farmers and PO Supervisors

A one day training programme for Co-operator farmers of Gazipur & P O Supervisors on the use of bio-slurry in homestead vegetable garden was organized at OFRD, BARI, Joydebpur and Gazipur. A total of 20 cooperator farmers & PO supervisor were participated in this programme. The participants were actively participated and agreed to implement homestead gardening and proper management of bio-slurry. Information of this programme given below:

Venue	Date	No. of participants
Seminar room of library, BARI, Gazipur	6 March, 2008	20

Farmers Training:

According to annual plan 2007-2008, a total of 75 farmers will be given training on Bio-slurry management at 10 management units of OFRD all over the Country. The programme was conducted at Pabna, Rangpur, Tangail, Faridpur and Mymensingh. Training programme at rest 5 (Five) location will be conducted after getting 2nd allotment.

6.0 Monitoring

Both IDCOL and BARI personnel monitored the Bio-slurry Project Activity time to time. Global Biogas Practice Leader Wim van nes, Senior NDBMP advisor Mr. Sunder P. Bajgain and advisor Dr. M. Fokhrul Islam visited the experimental plots and laboratory activity and expressed their satisfaction. S. M. Formanul Islam, S. M. Monirul Islam, Md. Ashrafuzzaman, Nazmul Haque Faisal and Mohammad Wahidur Rahman of IDCOL also visited the project activity time to time.

Director General & Director (Research) of BARI and CSO of Soil Science Division & On Farm Research Division visited the experimental field across the country and expressed their satisfaction over the project.

Picture 5. Director General BARI inaugurating the training programme on Bio-slurry

Picture 6. Farmers' Training programme on Bio-slurry at Phulpur, Mymensingh

7.0 Financial Statement

Summary Budget of Biogas Slurry Project

Sl. No.	Item of expenses	Taka		
		Expenses of SSD	Expenses of OFRD	Total expenses
01.	Honorarium for Coordinator, Principle Investigators, Co-Investigators and Laboratory technicians	87,000/-	35,000/-	1,22,000/-
02.	Chemicals	4,09,800/-	-	4,09,800/-
03.	Annual Review Workshop (Report writing)	10,000/-	10,000/-	20,000/-
04.	Training	23,940/-	40,050/-	63,990/-
05.	Experimental expenditure	36,936/-	4,59,061/-	4,95,997/-
Total		5,67,676/-	5,44,111/-	11,11,787/-

(Eleven lakh eleven thousand seven hundred eighty seven taka only)

Financial Progress

Sl. No.	Item of expenses	Approved Allocation by IDCOL	Fund released to date	Expenditure incurred up to 8-9-08	Balance
01.	Honorarium for Coordinator, Principle Investigators, Co-Investigators and Laboratory technicians	1,22,000.00	-	-	Nil
02.	Chemicals	4,09,800.00	2,70,000.00	2,70,000.00	Nil
03.	Annual Review Workshop (Report writing)	20,000.00	-	-	Nil
04.	Training	63,990.00	45,320.00	45,320.00	Nil
05.	Experimental expenditure	4,95,997.00	2,85,288.58	2,85,288.58	Nil
		11,11,787.00	4,00,610.58	4,00,610.58	Nil

8.0 Recommendations

About 5,000 biogas plant was constructed by different organizations with the finance of IDCOL/SNV throughout the country. But research activity of this project was done in only 45 biogas plant. So the project activity should be continued with the remaining biogas plant.

Manural value and heavy metal status of 45 biogas plant (all were cowdung & poultry based) were determined this year. So, the laboratory analysis study should be continued with remaining biogas plant using different organic sources. Again it is important, to know the mineralization rate of all kind of bio-slurry. This study should be conduct in the coming year.

Field trials with bioslurry on some crops were conducted this year. So, this study should be continued to confirm the findings of this year and expand this study in the coming year with other crops grown at different AEZ.
On farm verification trial on bioslurry should be started throughout the country to popularize the biosluury on agriculture. Use of lequid bioslurry on crops and fisheries is also important. This activity need to be expanded.

Training on management and utilization of bioslurry in agriculture was started in small scale this year. This training programme should be continued in large scale in the coming year.

9.0 Acknowledgement

BARI authority is highly acknowledge the IDCOOL/SNV for the finance of bioslurry project. Excellent cooperation from the management of IDCOL & NDBMP is also appreciated. Thanks given to senior advisor Mr. Sunder P. Bajgain and advisor Dr. M. Fokhrul Islam for editing the project report. S. M. Formanul Islam, S. M. Monirul Islam, Md. Ashrafuzzaman, Nazmul Haque Faisal, Mohammad Wahidur Rahman and other personnel of IDCOL help time to time during the project completion period.