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Transformation of Waste into Resource through Proper Dumping Site Selection: A Case Study in Kurigram Sadar Upazila,

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----------Abstract----------

Kurigram Sadar Upazila is one of the under developing upaliza's of Bangladesh which is occupied by 0.25 million people of an area of 265.75sq. Km.; the main occupation is farming where living about 40,000 farmers. This upazila produces about 1, 500000 Kg/month solid waste but still has not got any declared waste disposal site. This is creating major threat to the environment, high risk to human health, plants and animals. To get rid of it few soil samples of the studied area have been collected for geotechnical analysis to determine the best sites and out of eight sites four sites have been chosen for waste disposal. Mogalbachha has been preferred (out of eight sites) as a waste treatment site from all aspects. Considering the massive volume of the waste, type of waste, quantity, main occupation and degree of development of the area has been proposed that, this upazila is ideal for 'Waste to Organic Fertilizer' project. Still the agriculture sector is mainly chemical-based which degraded the natural resources, particularly soils, polluted surface and groundwater resources. Lately, organic-based agricultural production is a rapidly emerging technology, which has been applied allover the world and becomes profitable, popular and environmental friendly. In this research the best combination and procedure of organic waste has been proposed from all aspects. Applying this proposal government will be able to provide free of cost organic fertilizer to all the farmers of the upazila, don't have to pay subsidy on fertilizer, creates some job opportunity and make profit about 3, 00, 00,000 taka yearly.

Keywords *- Assessment of Environmental Impact, Suitable Site Selection, Waste Management, Geotechnical Analysis.*

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I. INTRODUCTION

Kurigram Sadar Upazila is at the northwest part of Bangladesh; latitude $25^0 45'$N to $25^0 55'$N and longitude $89^0 35'$E to $89^0 50'$E. It is occupied by 0.25 million people of an area of 265.75sq. Km., and is one of the under developed upaliza's of the country. The land form is mainly dry to medium dry and partially wet to marsh; high to medium land. The rivers Brammaputra and Dharala passed through of it. The upazila has got about 825 ponds, 15 deep tube wells, 2,148 shallow tube wells [Report of Land and soil resource].The average annual rainfall is about 2,123 mm, with seasonal cyclones, day temperature ranges from 7 to 12 ºC in the cool months and in the other months it varies between 23 to 30 ºC. One third land of the upazila gets flooded every year in the rainy season.

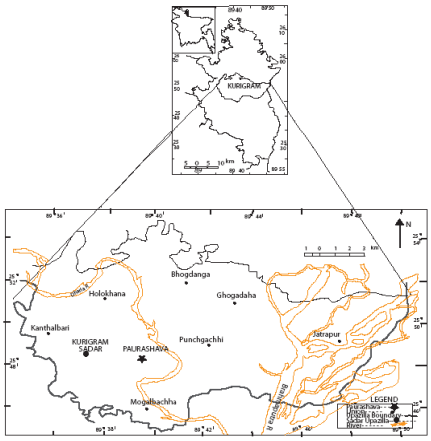

Figure-1: Location map of the study area.

The main occupation is farming; nearly 40,000 farmers and most of them are living under poverty line. Health is hazard because of poverty, education, backwardness and proper schooling of this upazila. Government has already taken some good steps to overcome of it. The present research might help the government by best waste sites selection, converting the waste into resource like organic fertilizer for free distribution among all the farmers and sells in the market to make money that can be used for the development of the upazila. This project will also create some job scope to uplift the economy. The daily solid waste of this upazila is about 50 tons per day [Chairman, Kurigram Municipality Corporation] ; about 70% organic waste that is biodegradable, 30% non biodegradable mostly polythene, plastic, glass. At present there is no waste management of the municipality, so the authority is disposing all types of waste including sewerage and solid waste in the low-lying areas without any technical or social consideration which creating huge environmental impacts like different health hazards diseases of the local resident. Proper waste management (like waste collection, transport, shorting, processing, recover it into a resource) undertaking by the local government (Kurigram Sadar Upazila Municipality) can play the most vital role of this project.

II. OBJECTIVE OF THE STUDY

The main objectives of the study as below:

- An assessment of environmental impact of improper solid waste disposal.
- Suitable sites selection for waste disposal considering geological and geotechnical methods and
- Converts the waste into a resource like organic fertilizer to boost up the economy of the upizala.

2.1 Materials:

1. Geomorphic map of Kurigran Sadar Upazilla and its surrounding area from Two SPOT imagry, of 1991.
2. Local Government Engineering Department (LGED): Base map.
3. Soil Resource Development Institute (SRDI): Soil and land form map of Kurigran Sadar Upazilla.
4. Department of Public Health and Engineering (DPHE): Deep tube well bore log.
   Bangladesh Agricultural Development Corporation (BADC): Deep tube well bore log and ground water level.

2.2 Methods:

The study was conducted to identify the environmental impact of inappropriate solid waste disposal, suggest best possible sites for waste disposal and converts the waste into a resource. In order to do that, grade of water contamination (surface and underground) and the rate of health hazard diseases have been identified. Few water samples have been collected from tube wells and surface for physical test and chemical test. For site selection deep tube well bore log collected from different sources have been use to delineate subsurface lithologic condition and identify the water table of the studied area. Soil samples have been collected for Geotechnical analysis (porosity, permeability and plastic limit) to determine the best sites. Finally 'waste to organic fertilizer' is just like a hot cake and applying all over the world; and the waste treatment process has been modified in aspect of degree of development, economy and geology of the studied area

III. ENVIRONMENTAL IMPACT OF IMPROPER WASTE DISPOSAL

Kurigram Sadar Upazila produces about 1, 500000 Kg/month solid waste but still has not got any declared waste disposal site. The municipality authority is disposing all types of waste including sewerage and solid waste in the low-lying areas without any technical or social consideration. It creates bad smell, unclean road, drainage congestion etc and finally becomes a major threat to the environment, high risk to human health, plants and animals.Water pollution occurs when pollutants are discharged directly or indirectly into the water bodies without any/ adequate treatment to remove harmful compounds. Exactly it is happening in Brammaputra, Dharala river and ponds of the upazila, because water running off from improper waste dumping, drainage, untreated sewage, gray water (water from showers, sinks, dishwashers and cloth washers), unclear road, pesticide and fertilizer of farms which can kill hundreds of marine mammals, countless fish and birds. Sometimes solid waste like our garbage can contains hazardous waste as old batteries, bug spray cans and paint thinner and these are always threats to public health and environment. Human waste should be transported as sewage in waste water through sewerage system but lack of hygiene and sanitation practice of this upazila not treated it properly. Sometimes the small kids don't use the toilet rather they do it in the open air. But they don't know human waste can be a serious health hazard as it is a good vector for both viral and bacterial diseases.

The degree of water pollution diseases (like diarrhea, cholera, typhoid and anemia) is increasing gradually according to local thana health complex but unfortunately they did not provide any authentic data of it. But during the field study local people informed the author that most of the time the children get sick by diarrhea and cholera; and the pregnant women and small children are victim of anemia it cause of deaths sometimes. The presence of big amount of vermin (rats and mice) has been noticed during the field work which indicates the impact of inappropriate waste dumping. It is all known that vermin can spread plague. Sometimes solid waste like our garbage can contains hazardous wastes as old batteries, bug spray cans and paint thinner and these are always threats to public health and environment.Water

pollution can be measured by physical, chemical and biological methods. Four underground water (shallow tube well) and four surface water (ponds) have been analyzed by physical and chemical methods. The surface water's samples were slightly dark colored, slightly bitter test, slightly bad odor, not transparent and pH is around 4. The underground water's samples were colorless, test less, transparent with pH around over 5. The result concludes that the water of the area has been already polluted and improper waste dumping may one of the key reasons and water pollution can be exposure through food, drink and it has severe impact for the generation.

IV. GEOLOGY OF THE STUDY AREA

The study area is covered by recent alluvium deposit by the Brammaputra and Tista rivers. The subsurface geology of this area is established on the basis of 8 bore logs data collected from DPHE, Kurigram which is expressed the lithology, bed thickness and water table of area. On the basis of lithologic characteristics the sub-surface stratigraphy of the study area is consists of mainly Sand (fine to medium and coarse grained sand) and Clay (clay and silty clay). Primarily eight sites have been suggested for waste disposal and those areas are Jatrapur(S1), Mogalbachha(S2) ,Belgachha(S3), Pangachhi(S4), Ghogadaha(S5),Bhogdanga(S6), Kanthalbari(S7), Holokhana(S8) on basis of bore logs data. The fence diagram revels the lithology, bed thickness and water table of those areas. In the fence diagram Pangachhi(S4) and Ghogadaha(S5) have not been used for best look figure. The primarily proposed eight areas are covered by Clay with thickness of 3m to 10m, and geomorphologically flood plain areas. 'Clay' is not mandatory for waste disposal site selection but still it could be better choice because of its geotechnical characteristics like permeability, porosity, non swelling and good for hazard waste disposal.

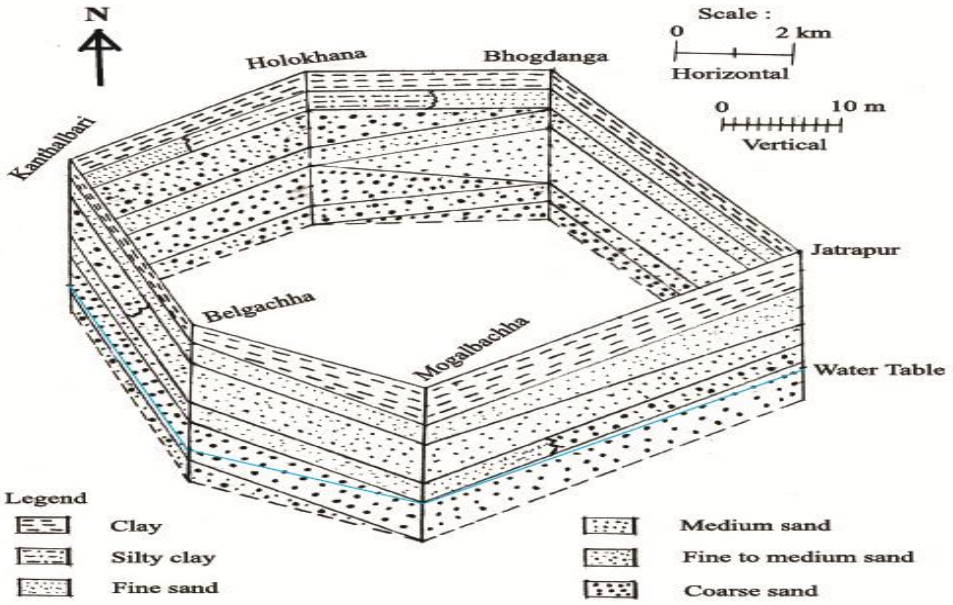

Figure-2: Fence Diagram (according to the supplied data of BADC, Kurigram Zone, 1989) considering thickness up to 80 ft (24.384 m) with water table.

(Scale: Horizontally, 1cm = 1 km; vertically, 1m = 0.2 cm)

V. GEOTECHNICAL ANALYSIS

Geotechnical analysis is specially concern with geological studies relevant to engineering, environmental concern and safety which are essential part in locality, planning and constructing large civil engineering projects with economically safe and stable design. In the present study the following properties are needed to determine the porosity, permeability and consistency limits of the primarily proposed eight areas

VI. RESULTS

Eight soil samples have been collected from eight sites (S1 to S8) and porosity and permeability have been tasted in lab. The obtained porosity varies from 52% to 59% and permeability from 10^{-3}mD to 10^{-5}mD of the studied areas.The term consistency meant the relative case with soil can be deformed, mostly used for the fine-grained soils for which the consistency is related to a large extent to water content. Eight samples have been collected of the proposed sites for both plastic limit and liquid limit test. Liquid limit of all samples have done successfully according to ASTM-method D423, but plastic limit of one sample named Bhogdanga (S6) could not be done according to BS 1377: test 3 (ANON, 1991). This was crumbled before reaching 3mm thread as required for the plastic limit test due to more silt percentage. Out of eight

samples where both plastic limit and liquid limit test have done, liquid limit test values of four samples named Pangachhi(S4), Ghogadaha(S5),Bhogdanga(S6), and Holokhana(S8) are unrealistic. Plasticity chart (Fig.3) shows that sample S2 (from Mogalbachha), sample S3 (from Belgachha) and sample S7 (from Kanthalbari) are clay of high plasticity, and sample S1 (from Jatrapur) are clay of intermediate plasticity. According to liquid limit viruses plasticity index chart for common clay minerals (Fig.4) the samples are Illite clay mineral which is non-swelling in character. So, out of eight primary proposed sites only four sites have been finally suggested for waste disposal on the basis of above results and the areas are Kanthalbari(S7), Jatrapur(S1), Mogalbachha(S2), and Belgachha(S3).

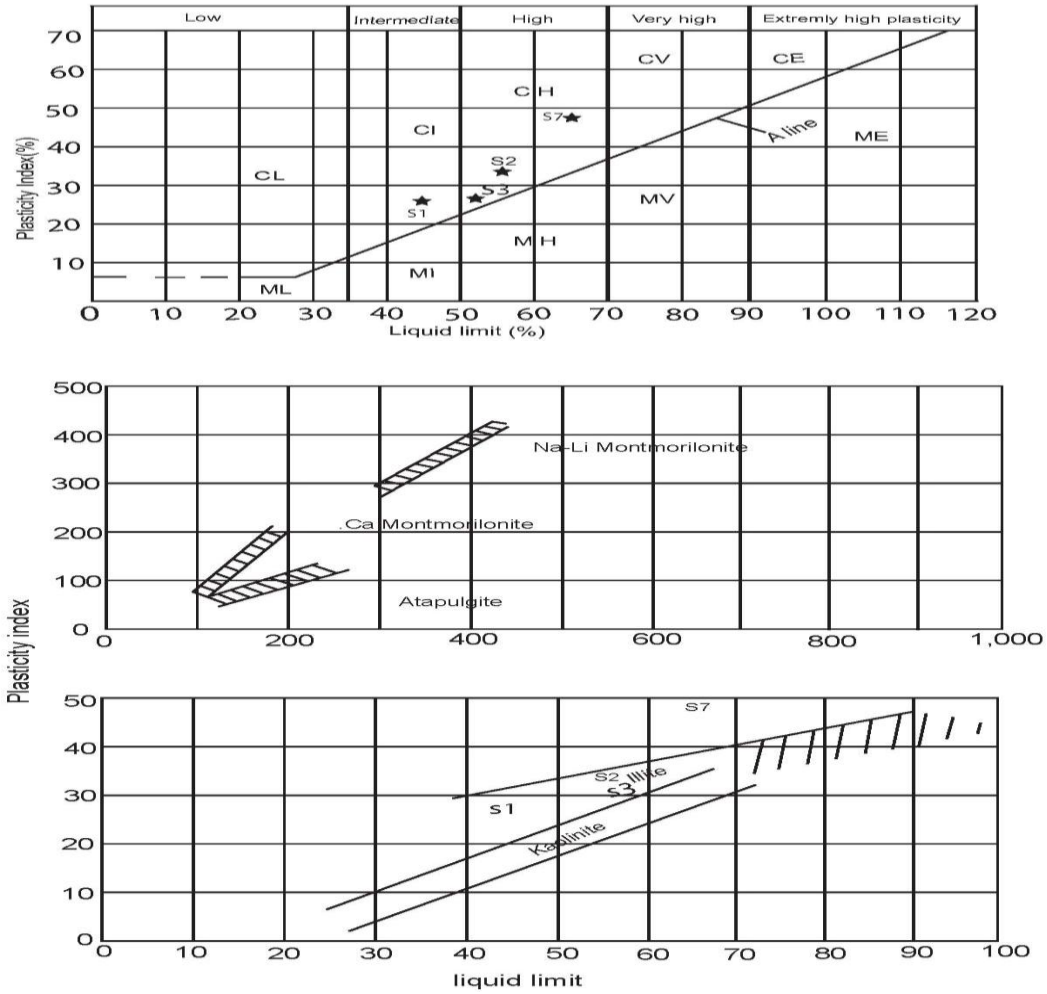

Figure-4: Liquid limit versus plasticity index for the common clay minerals. (Modified after Grim, 1962).

Table-1: Result of geotechnical analysis of the final suggested area.

Name of Sites	Thickness of surface layer in M	Water table from surface in M	Porosity in %	Permeability in mD	Plasticity index
Kanthalbari	3.1	33.1	58	10^{-3}	Intermediate
Jatrapur	6.2	32.6	54	10^{-4}	High
Mogalbachha	6.2	33.2	52	10^{-5}	High
Belgachha	4.1	32.4	55	10^{-6}	High

VII. DISCUSSION

Waste disposal site involves a consideration of economic, social factors, geological, geotechnical and hydro-geological conditions. From geological point of view, the waste disposal site should be away from recent flood plain, wetlands, unstable areas, seismically active zone and faulted areas (ANON, 1991). A waste disposal site should be selected ensuring aesthetic importance of the area. The site should be at least 200 meters away from residential area (Bell, 2003), so that the insect, pest or bird would not disturb the neighborhood. The type and thickness of the topmost layer upon which the waste will be dumped is the most important factor to select a waste disposal site. If the topmost layer is Clay with acceptable thickness could be best site, because thick clay layer can prevents the leaching to contaminate the ground water because of impermeability of the clay. The suggested four sites Kanthalbari, Jatrapur, Mogalbachha, and Belgachha are free from fault, any seismic activity and hydro-geologically acceptable which would not threat both ground and surface water. These four sites are consisting of good quality Clay (Illite type) with acceptable thickness, good permeability, minimum porosity, and high to intermediate plasticity non-swelling characteristics.All the sites do not flooded in recent past, well connected with city center, far from residential area and are safe from any kind of air pollution or biologic effect. From extensive consideration of economic, social factors, geological, geotechnical and hydro-geological aspect the proposed four sites will be best for the studied area.

7.1 WASTE MANAGEMENT

Waste would be huge (1, 500000 Kg/month) within very short time and could be a major threat to the environment, high risk to human health, plants and animals. Only proper waste management practice can converts the waste into resource. Not only Municipality but also local people can play an important role of it. Actually waste management practice depends on type waste, quantity, main occupation and degree of development of the area. From all aspects Kurigram sadar upazila is ideal for 'Waste to Organic Fertilizer' project.

7.2 WASTE TO ORGANIC FERTILIZER

It is already mentioned that population of the upazila is about 2, 42,513; main occupation is farming and nearly 40,000 farmers are living here; and is one of the developing upazila's of Bangladesh. The daily waste is about 50 tons per day; about 70% organic waste that is biodegradable, 30% non biodegradable mostly polythene, plastic, glass.Considering the massive volume of the waste, something has to be done to convert these wastes into a resource. Most of these wastes are biodegradable and can be converted into valuable resources that reduce their otherwise negative impacts. Currently technology has developed ways to convert solid wastes into a valuable resource like Organic Fertilizer and its subsequent utilization as a source of plant nutrients in intensive small-scale organic-based vegetable production and for sustaining soil health and productivity. The agriculture sector is basically chemical-based farming that makes a considerable contribution to the degradation of the natural resources, particularly soils. Heavy application of fertilizers has polluted surface and groundwater resources. Nowadays, organic-based agricultural production is a rapidly emerging technology, which can partially solves waste disposal problems through conversion of biodegradable wastes into organic compost; ensures the accessibility of organic fertilizer. In addition, organic-based vegetable production provides unique opportunities for producing high quality vegetables because of reduced chemical application at any given time of the year. It likewise contributes to rehabilitating and sustaining the fertility of our croplands that have been degraded or are in danger of degradation due to intensive crop production and improper soil management practices. The organic fertilizer can be used in eggplant, cauliflower, broccoli, tomato, carrot, okra, garlic, onion, ginger, peas, peppers, cucumber, sweet corn, lettuce, cabbage, pumpkin, green beans etc.

VIII. WASTE TREATMENT PROCESS

Step-1: It is already mentioned that Kanthalbari, Jatrapur, Mogalbachha and Belgachha have been suggested for waste disposal site; then all the waste should bring at waste treatment site at Mogalbachha. Mogalbachha has been preferred because it is very good quality thick (6.2 m) clay (Illite type) with high plasticity and 3 km distance from the city center, dry landform, high to medium land; moreover it is comparatively less populated, and good transportation facility.

Step-2: Polythene should be laid on the floor of tin shaded waste treatment site Mogalbachha before dumping waste to protect leaching.

Step-3: Waste sorting is very important because non biodegradable waste do not need for waste to organic fertilizer project rather it is (non biodegradable waste) sellable. It is already discussed that Kurigram sadar upazila produce about 1, 500000 Kg/month waste where nearly 1,000000 Kg/month organic waste and 500000 Kg/month non biodegradable waste.

Step-4: The biodegradable organic waste needs shredding.

Step-5: The best combination is as Organic waste: Buffalo manure: Rice hull ash at a ratio of 2:1:1 [Nenita E. dela Cruz1 et.al].

Step-6: The combined solid waste (Organic waste, buffalo manure and rice hull ash) is needed to mix properly, added water and piled under shaded area for decomposition. The total decomposition takes 27-30 days then it needs to spread in the sun to dry it up and it takes 6-7 days [Nenita E. dela Cruz1 et.al]. Then the produced organic fertilizer gets ready for use.

IX. IMPLICATIONS AND RECOMMENDATIONS

The conversion of solid wastes into a valuable resource such as organic fertilizer is a significant strategy for saving the Earth from further degradation generated by improper waste disposal and management. Moreover, the continuous use of organic fertilizer as a source of plant nutrients for vegetable production not only reduces the cost of fertilizer but serves as the ultimate solution for restoring the lost fertility of agricultural soils as well as soil health; this leads to sustained soil productivity.Production of organic fertilizer from solid wastes and its subsequent utilization in crop production and soil rehabilitation is therefore recommended to reduce the volume of wastes that are brought to dumpsites, minimize environmental pollution and degradation and increase the productivity of agricultural land.As Bangladesh is an agricultural based country, government doing his best level to boost up this sector. Lately the price of fertilizers increased rapidly allover the world but Bangladesh government still providing fertilizers in very cheap price to the farmers because government is spending huge amount of money for subsidy on fertilizers.The present author offers few recommendations that might be helpful for the government and farmers to move up the faming of this upazila.

- This project will be controlled by local Municipality Corporation under one project manager and he will be assisted by four supervisors and 45 workers will work in this project.
- In the first phage of this project creates 50 job opportunities which will gradually increase within very short time and this will help the government to fulfill the promise ‘one person from each family will be provided a job’.
- The production of organic fertilizer from waste requires the waste sorting area, shredding area, composed of assembly area, composting area, drying area, packing area, storage area and drainage sock well system. The local government (Kurigram Sadar Upazila Municipality) will ensure all those facilities.
- Kurigram Sadar Upazila Municipality will provide free of charge yearly total 20Kg (10 Kg fertilizer in March and 10 Kg in October) organic fertilizer to all the farmers (40,000 farmers) of the upazila.
- If any farmer wants more organic fertilizer, he can bye it from local government (Kurigram Sadar Upazila Municipality) at present market rate.
- 10 Kg organic fertilizer can be used in 0.33 acre land (amount of fertilizer depends on the fertility of the land).
- The local government (Kurigram Sadar Upazila Municipality) will launch work shop, training, advertisements and free of charge advice regarding the use of the fertilizer.

  If this project will successful, it can apply allover Bangladesh.

X. PROJECTED PRODUCTION RATE, FREE DISTRIBUTION, COST AND BENEFIT OF THE PROJECT

The average production of organic fertilizer is 10% of total combined waste [Gusri Effendi S.]. It is already mentioned that the best combination is as, Biodegradable waste: Buffalo manure: Rice hull ash at a ratio of 2:1:1. Biodegradable waste is free of cost but buffalo manure (or cow dung) and rice hull ashes have to buy. The non biodegraded waste is about 500,000 kg waste (let 50% of it) is sellable at 1,250,000 taka (5 taka/Kg). Production cost of each cycle comes as; for rice hull ashes 2,000,000 taka (maximum rate 4 taka/Kg), for cow dung 500,000 taka (maximum rate 1 taka/Kg), employed 50 people’s monthly salary 200,000 taka, packing cost 100,000 taka and the other cost 200,000. Each cycle total production cost comes 1,750,000 taka **(**2,000,000+500,000+200,000+100,000 +200,000-1,250,000=1,750,000**).** The price of fertilizer is variable and the present government providing fertilizers at is 25 taka/Kg (variable) price on subsidy to support the farmers.

Table-2: Projected table for one cycle (27-30 days).

Name of item	Weight in Kg	Cost in taka
Organic waste	1,000,000	Free
Buffalo manure/ Cow dung	500,000	500,000 (1 taka/Kg)
Rice hull ash	5,00000	2,000,000 (4 taka/Kg)
Produced fertilizer	200,000	3,250,000 (5,000,000-1,750,000) (25 taka/Kg)

Table-3: Projected production and net cost at the end of the year.

Name of item	Weight in Kg	Net cost in taka
Each cycle produced fertilizer	200,000	3,250,000
Whole year produced fertilizer	2,400,000	39,000,000

Each year 12 cycles (2,400,000 Kg) of fertilizer production is possible and its net cost 39,000,000 taka. Local government is suggested to provide free of cost organic fertilizer twice in a year to all the farmers and it will be the production of 4 cycles (800,000Kg) fertilizers and its cost 1,00,00000 taka; and the remaining fertilizer production of 8 cycles (1600,000Kg) is totally sellable and its price is about 29,000,000 taka . So, at the end of the year total profit will be 29,000,000 taka (39,000,000-10,000,000) from 8 cycles (12-4 cycles)

Table-4: Projected costs benefit data.

Name of Item	Weight in kg	Taka
Annually total production	2,400,000	39,000,000
Annually total free distribution	800,000	10,000,000
Annually sellable after distribution	1,600,000	29,000,000

XI. CONCLUSION

The project 'Waste to Organic fertilizer' would be unique project for developing countries like Bangladesh. Lately it has been applied all over the world and becomes profitable, popular and environmental friendly. The Central Luzon State University (CLSU), Philippines, has devised ways to convert solid wastes into a valuable resource — organic fertilizer — and its subsequent utilization as a source of plant nutrients in intensive small-scale organic-based vegetable production and for sustaining soil health and productivity. Government will be able to provide free of cost organic fertilizer without paying any subsidy on fertilizer to all the farmers of the upazila. It will create 50 job fields which will gradually increase within very short time and this will help the government to fulfill the promise 'one person from each family will be provided a job'. Moreover, local government will be able to make profit about 3, 00, 00,000 taka yearly.Converting solid waste into organic fertilizer will not only increase farm household income but also become a stable source of organic fertilizer for rehabilitating highly nutrient depleted agricultural soils and reduce environmental pollution generated by improper waste disposal

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