ASSESSING FARMERS' ATTITUDE TOWARDS COMPOST GENERATED FROM KCC SOLID WASTE

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EXECUTIVE SUMMARY

Compost is the end product of decomposition of MSW (organic matter). Farmers in Bangladesh mostly rely on chemical fertilizers for higher production without or less application of compost. Despite huge potential, compost sector in Bangladesh is facing three major constraints: complicated and time-consuming licensing procedure, weak market demand for composting technology; and lack of awareness among farmers on benefits of using compost. This study investigates the farmers' attitude towards KCC solid waste generated compost which is the sustainability indicator for solid waste management. The study was conducted at *Khornia Union* under *Dumuria Upzila* which is near to *Khulna* city where different NGOs sold different types of compost generated from KCC solid waste. However, the results of the study show that about 90% farmers said that they used compost in their agricultural field. But only 32% farmers used KCC generated compost in their agricultural land. Low availability of compost (37%) and lack of information about compost (51%) are the main reason for less use of compost in their agricultural land. Moreover, 61% farmers said that rice production increased by 200 kg/hectare due to compost uses in their agricultural field. About 42% farmers said that vegetable production increased by 320 kg/hectare due to compost uses in their agricultural land and 32% said that vegetable production increased by 280 kg/hectare. Statistical analysis shows that on an average rice production increased by 201 kg per hectare and on an average vegetable production increased by 310 kg per hectare. The people of the survey area think that if producers sell their product directly to farmer then the price of the compost will be lower and the quality of compost may be much better than market compost, which is suitable for their farming. 62% of the farmers think that the quality of KCC generated compost is low and sometimes different objectionable ingredients is found in KCC generated compost such as, bone of different animals, fish etc. They also said that they will be interested to buy compost more if such constraints are overcome and the quality of KCC generated compost is improved by arranging proper training with knowledge sharing about compost uses in agricultural fields. It is found that 15% of the farmers are willingness to buy compost at a rate of Tk. 10 per kg, 44% at a rate of Tk. 15 and 33% at a rate of Tk. 20. Only 8% farmers were wanted to buy compost at a rate of Tk. 20 per kg. Statistical analysis shows that farmers are willing to buy KCC compost at a rate of approximately Tk. 16 per kg.

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LIST OF ABBREVIATIONS

DAE	Department of Agricultural Extension
DtD	Door to Door
KCC	Khulna City Corporation
LDAC	Least Developed Asian Country
MSW	Municipal solid waste
NGO	Non Governmental Organization
SDS	Secondary Disposal Sites
SPS	Somaj Progati Songastha
SWM	Solid Waste Management
WTP	Willingness to Pay
UDS	Ultimate Disposal Site

CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Solid waste management has continued to be a major challenge in rapidly growing cities of the developing country like Bangladesh. A high population growth rate and increasing per capita income have resulted in the generation of an enormous volume of solid waste and thereby, improper disposal which poses a serious threat to the environmental and human health. Proper disposal of solid waste is of paramount importance because of its infectious and hazardous characteristics. The improper management of solid waste especially in peri-urban areas causes serious environmental problems in terms of air, water, and soil pollution.

Khulna is the third largest city in Bangladesh. Khulna city consists of peri-urban and urban areas as the city is considered to be a rapidly growing city in Bangladesh. The city consists of low income people with higher income groups and slums located throughout the city. An enormous volume of solid waste is generated daily from Khulna City Corporation (KCC). KCC is responsible for the management of solid waste as KCC is responsible for the operation and maintenance of municipal services. Generally, KCC collects solid waste from about 1200 KCC masonry bins which are usually located on KCC roadsides. After disposal of solid waste into the masonry bin by the KCC dwellers, the solid wastes are then transported by KCC trucks to final disposal site which is about 8 km from KCC. But it is observed that many of the KCC households usually do not dispose of their solid waste into the KCC bins, whereas the solid wastes are frequently disposed of into KCC open drains and on roadside. But KCC waste collection trucks only collect solid waste from masonry bins. As a result, it poses a substantial threat to the urban environment of KCC and human health too. In the past, a number of projects for community based solid waste management in KCC area were launched by different organizations. For example, *Somaj Progati Songastha* (SPS) engaged in community based solid waste management practices in KCC ward no. 9, 14 and 16, especially in *Boyra* area of KCC and SPS would produce compost and sell it to the farmers of *Dumuria Upazila*, Khulna. However, the pilot project for community based solid waste management in KCC was launched in 1997 by *Prodipan*, a local NGO in KCC. *Prodipan* has worked in association with KCC (WSP, 2000;

SPS, 2012). But they worked in only 6 wards of KCC. Now, the mentioned organizations are less actively engaged in community based solid waste management in KCC area. But sustainability is a major challenge for such community based solid waste management practices in urban areas and in this case, composting and compost marketing can help towards sustainability of the solid waste management projects. Generally, a co-marketing policy for compost with chemical fertilizers would make compost more competitive in agricultural markets. Therefore, the present study will assess the willingness to pay (WTP) by the compost using farmers and their opinion regarding compost uses in agricultural fields.

1.2 Justification and scope of the study

In the rapidly growing cities of developing countries, urban solid waste management is currently been regarded as one of the most immediate and serious issues for city authorities. Due to inadequate and often inefficient solid waste management and visible environmental degradation, solid waste – generated at an increasing rate – has also become an important environmental issue for the residents of the major cities in Bangladesh. In Bangladesh, the urban population has been increasing at a very steep rate. Management of these steeply increasing vast quantities of solid wastes is a very complex process indeed. Due to severe financial constraints, absence of appropriate technology, lack of people's awareness, motivation and participation, ineffective legislation and law enforcement to protect the environment and to handle the waste, the whole system is becoming a threat to city dwellers, planners and other stakeholders. To ensure a clean, hygiene and environmental-friendly city, the city authority is looking for a safe and sustainable solution for the appropriate management of solid wastes.

Compost is the end product of the municipal solid waste which is sustainable for MWS management. In Khulna city daily household waste generation rate is 0.2 kg/ household which create just less than 300 tons of solid waste in the city area. But only 20 to 25 tons waste is used for compost production by many NGOs like SPS, PRODIPON etc (ADB, 2009). But lack of knowledge about compost among peoples, it is not popular. So the production of compost decreases and NGOs does not want to produce compost more for lack of capital. For this reason MSW management is not sustainable and MSW creates environmental degradation in city area. So, the study has investigated peoples' attitude towards the compost generated from MSW in

KCC area. The study has also investigated the compost marketing model and willingness to pay (WTP) for compost purchase. By identification of these we can manage MSW in the peri-urban area of Khulna city.

1.3 Objective of the study

The overall aim of the present study is to study of the pricing of compost by farmers.
The objectives of the study are as follows:

(a) To get farmers' attitude towards using compost in agricultural fields as compared to chemical fertilizers;
(b) To get farmers' attitude towards usefulness of compost in agricultural fields as compared to chemical fertilizers;
(c) To get farmers' attitude towards compost sale/marketing model; and
(d) To assess willingness to pay (WTP) by the farmers for compost

CHAPTER TWO
SOLID WASTE MANAGEMENT AND COMPOST

2.1 Solid waste management

2.1.1 Municipal solid waste in Bangladesh

Municipal solid waste (MSW) is the heterogeneous composition of wastes that are organic and inorganic, rapidly and slowly biodegradable, fresh and putrescible, hazardous and nonhazardous, generated in various sources in urban areas due to human activities (Tchobanoglous, 1993). Its composition, characteristics and generation largely depend on geographical location, socio-economic settings, living standards, food habits and people's awareness. The properties of MSW and its management practice in Bangladesh are described as follows.

2.1.2 Characteristics of municipal solid waste

Bangladesh, like most of the developing countries, is facing a serious environmental problem due to huge amount of MSW generation and its mismanagement. The study reveals that generation rate is very close in each major city. Overall, the per capita generation varies from house to house depending on the economic status, food habit, age and gender of household members and seasons. Table 2.1 and 2.2 show the generation of MSW in six major cities of Bangladesh as recorded in the year of 2005 (Alamgir *et al.*, 2005a). The Tables reveal that MSW is generated at a rate of 0.325 to 0.485 kg/cap/day obtained from different sources as 75 to 85% residential, 11-22% commercial, 1 to 1.5% institutional, 0.5 to 1.25% municipal services and 0.4 to 2.5% others. The compositions are 68 to 81% food & vegetables, 7 to 11% paper & paper products, 3 to 5% polythene & plastics and 9 to 16% others.

Table 2.1 Different sources in total generation of MSW in the six major cities of Bangladesh

Sources	**MSW generated daily from different sources (%)**					
	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Residential	75.86	83.83	85.87	77.18	79.55	78.04
Commercial	22.07	13.92	11.60	18.59	15.52	18.48
Institutional	1.17	1.14	1.02	1.22	1.46	1.29

Municipal Services	0.53	0.51	0.55	1.24	1.15	0.80
Others	0.37	0.60	0.96	1.77	2.32	1.40

Table 2.2 Generation of MSW in six major cities of Bangladesh

MSW Generation	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Population (Million)	11	3.65	1.5	0.45	0.40	0.50
MSW Generation (tons/day)	5340	1315	520	170	130	215
MSW Generation rate (kg/capita/day)	0.485	0.360	0.346	0.378	0.325	0.430

There is an insignificant variation of composition in MSW at six major cities of Bangladesh. The rapidly biodegradable portion is normally very high compared to other portions, essentially due to the use of fresh vegetables and in absence of food processing industries as revealed in Table 2.3 (Alamgir *et al.*, 2005b).

Table 2.3 Physical composition of MSW in six major cities of Bangladesh (in wet weight %)

MSW Composition	DCC	CCC	KCC	RCC	BCC	SCC	Avg.
Food & Vegetables	68.3	73.6	78.9	71.1	81.1	73.8	74.5
Paper & Paper Products	10.7	9.9	9.5	8.9	7.2	8.4	9.1
Polythene & Plastics	4.3	2.8	3.1	4.0	3.5	3.4	3.5
Textile & Woods	2.2	2.1	1.3	1.9	1.9	2.1	1.9
Rubber & Leathers	1.4	1.0	0.5	1.1	0.1	0.6	0.8
Metal & Tins	2.0	2.2	1.1	1.1	1.2	1.1	1.4
Glass & Ceramics	0.7	1.0	0.5	1.1	0.5	0.7	0.8
Brick, Concrete & Stone	1.8	1.1	0.1	2.9	0.1	1.8	1.3
Dust, Ash & Mud Products	6.7	5.1	3.7	6.5	3.1	5.3	5.1
Others (bone, rope etc.)	1.9	1.2	1.2	1.3	1.3	2.8	1.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Note: DCC- Dhaka City Corporation, CCC- Chittagong City Corporation, KCC- Khulna City Corporation, RCC- Rajshahi City Corporation, BCC- Barisal City Corporation, SCC- Sylhet City Corporation; Avg.-Average;							

The wastes contain high portions of volatile solids as 43 to 71%, ash residue as 29 to 57%, high moisture content as 56 to 70%, bulk density as 550 to 1125kg/m3, grain size from 2 to 200mm and pH from 7.7 to 8.7. Average values of some chemical constituents are 11.50% carbon, 0.91% nitrogen, 0.76% potassium and 0.33% phosphorous. The volatile solid contents are measured as 71, 54, 56, 48, 43 and 65%, while the ash residues are obtained as 29, 46, 44, 52, 57 and 35% for Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet city, respectively.

2.1.3 Situation of ultimate disposal sites

Despite source reduction, reuse, recycling and composting divert significant portions of MSW, large amount of wastes still need to be placed in landfills. There is no controlled/ engineered/sanitary landfill in Bangladesh. The sites are situated in and around the city areas of low-lying open spaces, unclaimed land, riverbanks and roadsides (Waste Safe, 2005). DCC operate three sites, namely, Matuail, Gabtali and Uttara; CCC operates two sites, namely, Raufabadh & Halishahar, while other city corporation, operates one site each, namely, Rajbandh by KCC, Shishu Park by RCC, North Kawnia by BCC and Lalmati by SCC. Crude open dumping sites are always incompatible with the surroundings. Wastes spreads all over the site are unsightly as no proper system maintain for filling the area. Wind blows litter and indiscriminate the dumping waste outside the site and on the surrounding surface water. The study also reveals that every site poses high threat to health and environment as shown in Table 2.4. Details situations are appeared in (Alamgir *et al.*, 2005b).

Table 2.4 Potential threat to health and environment caused by MSW in Bangladesh

Hazard point factors	MTL	GBT	RFB	HLS	RJB	SSP	NKW	LLM
Waste contents	30	30	30	30	30	30	30	30
Rainfall	2	2	4	4	2	4	4	4
Distance to drinking water aquifer	8	8	0	8	8	8	10	10
Site drainage	8	8	8	4	8	8	4	8
Potential to create leachate at site	4	2	4	4	4	4	4	4
Distance to drinking water source	4	2	2	2	0	4	4	4
Site accessibility	2	4	4	4	4	4	4	2
Frequency of burning	0	0	0	0	0	2	2	2
Site exposure to public and vector	4	2	4	4	4	4	4	4
Public concern over site esthetics	4	4	4	4	4	4	4	4
Total points	66	62	60	64	64	72	70	72
Note: MTL – Matuail, GBT – Gabtali, RFB – Raufabadh, HLS – Halishahar, RJB – Rajbandh, SSP – Shishu Park, NKW – North Kawnia, LLM – Lalmati; Low hazard – Points 13 or less, Moderate hazard – Points 14 – 29, High hazard – Points 30 or more. The relative threat to health and								

environment was evaluated by Indian Health Service (HIS 1998) report.

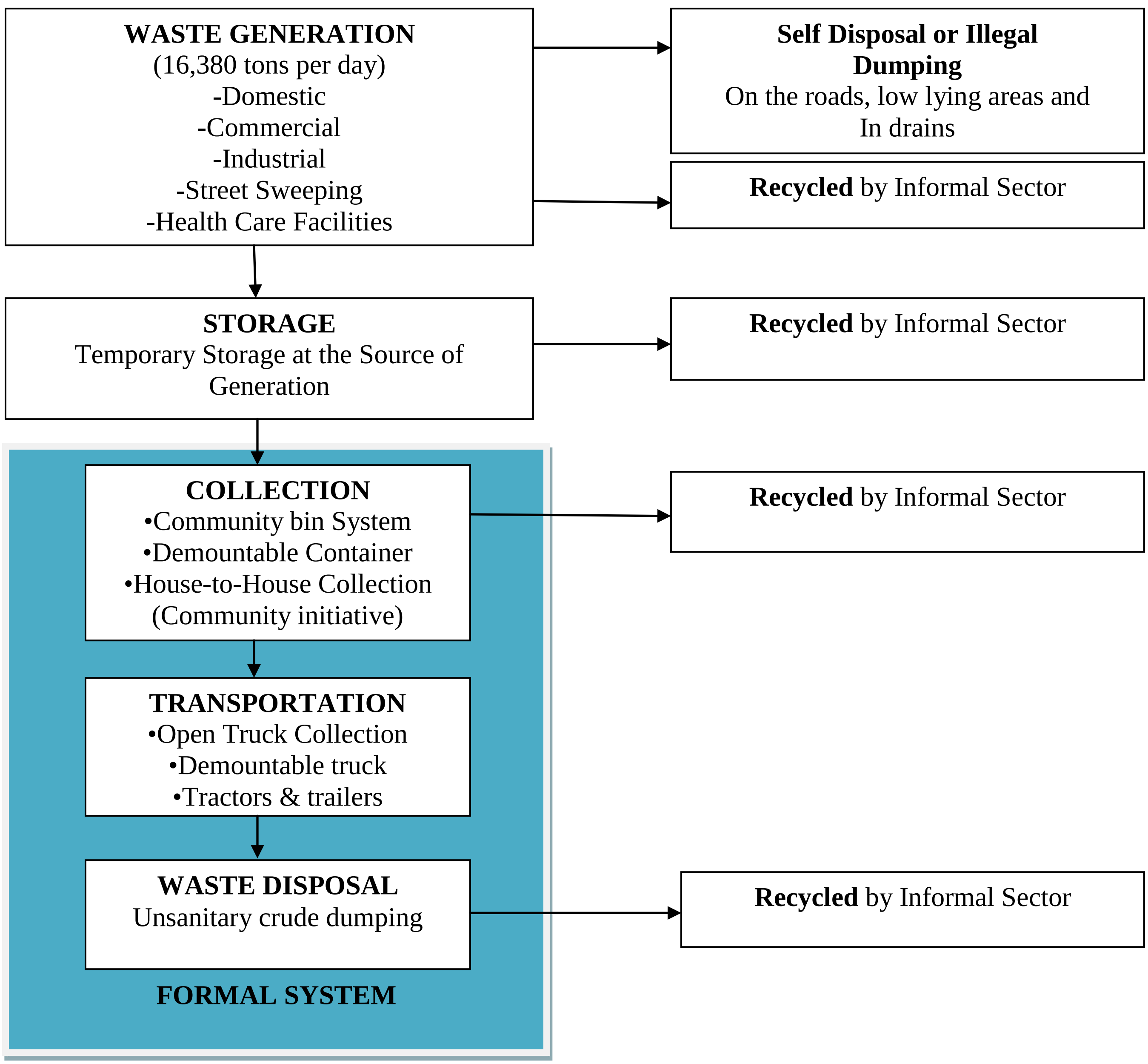
2.1.4 Scenarios of MSW management through recycling and treatment

In Bangladesh, generally recovery/recycling is carried out in three phases. Phase one is the source separation, where the generators separate refuse of higher market value such as papers & paper products, bottles, fresh containers, plastic materials, tin, glass, metal, old clothes, shoes etc. and sell it to street hawkers. In the second phase, the poor children of slum dwellers or street children known as "Tokai" collect different items of low market value from on-site storage bins/containers and open storage spaces. The items include broken glass, cans, cardboard, waste papers, polythene, rags, pet bottles, coconut shells, metals and miscellaneous commercial waste discarded by householders. The final phase is the recovering of reusable and recyclable materials from UDS. Scavengers/Tokais are salvaging recyclable wastes mainly when collection vehicles are being unloading at UDS. Recycling, reuse and reduce are do not get support from formal authority, even the composting, a great potential sector of waste treatment and minimization considering the nature of MSW in LDACs, fails to reach desired target due improper planning (Ali *et al*., 2004; Sinha and Enayetullah, 2000).

In Bangladesh is no incineration plant for combustion of MSW. Limited burning units are situated in some cities and at present it is not practices at large scale. Only burning of hazardous waste is done at high temperatures, which comes from different clinics/hospitals in the presence of sufficient air to achieve complete combustion. Generally dry wood and kerosene oil are used for burning. Different shapes and sizes of burning units are present in Bangladesh. A proper segregation scheme for separating hospital waste into hazardous and non-hazardous categories is therefore desired for Bangladesh. This should be coupled with proper separation of hazardous waste and treatment facilities so that co-disposal of hazardous waste with MSW can be avoided. Small scale composting of night soils and other organic wastes is common in some parts of Bangladesh (Ahmed and Rahman, 2000). During the field survey from May 2004 to April 2005, it was found that the composting activities have been initiated as organized base (Pilot-scale type) in six cities of Bangladesh, except Chittagong and Barisal, by different organizations including City Corporation, NGOs and CBOs. Mostly the processes adopted in these cities are windrow or active pile system. The barrel or small container composting methods is also introducing particularly in urban slums, colonies, etc. The small windrows or piles of about 3 tons pre-sorted waste mixture are manually formed on a bamboo frame. The bamboo frame is used to increase the passive aeration. Usually the piles are dismantled in every week for remixing and moisture adjustment. After six weeks the raw composts are again piled for final maturation (Alamgir *et al.*, 2007).

2.1.5 Existing management practices of solid waste management

CBOs and private organization work with city authorities. But the situation remains unchanged. The strengths and drawbacks at all levels of the existing wastes management system are identified by (Waste safe, 2005). Source storage and separation are done in an informal and uncontrolled means; hardly 30-40% of city dwellers practiced it. NGOs, CBOs and city authorities collect wastes from generation sources by door-to-door collection systems. Door-to door collection systems are introduced recently for wastes collection from generation sources; mainly from households and dispose the major portion of it to the nearest secondary disposal sites (SDS). Despite very positive impact of primary collection of wastes from source by door to-door system, the coverage of this system is very slim. City authorities collect these wastes from SDS and transfer it to the ultimate disposal site (UDS). The efficiency of the city authority is very disappointing. There is no special department to handle the situation MSW. Conservancy section, in general is conducting this job along with its other responsibilities such as street sweeping, drain cleaning, street lighting etc. As a result, required attention and efficient management could not be obtained from the responsible department of city authority as required (ADB, 2009).



Waste Generation Rate: 0.5 kg/ capita/ day
Collection Efficiency by formal System: 40%-50%
Recycling by Informal System: 10-15%
Self Disposal or Illegal Dumping (uncollected): 35%-50%)
Solid Waste Management Cost: 5-20% of the total annual budge

Fig 2.1: Existing pattern of solid waste management process in Bangladesh (Source: DoE, 2004)

2.2 Current situation of solid waste management in Khulna

Solid waste management (SWM) in Khulna, and in many other Bangladeshi cities, is hampered by the absence of adequate national or local legislation relating to municipal SWM and the treatment and disposal of hazardous waste. In particular, there are no mandatory regulations or performance standards for city corporations (e.g. KCC) to establish and manage an effective SWM system; nor are there any sanctions to prevent littering and indiscriminate dumping.

As a result SWM in Khulna has developed in a piecemeal and unintegrated manner with NGOs, CBOs, informal recyclers and private enterprises being involved along with KCC. Apart from one ward where KCC operates Door to Door (DtD) collection, its main responsibilities are the transport of waste from Secondary Disposal Sites (SDS) and roadside Dustbin Points (DBP) to the landfill site it operates about 8km to the west of the city. NGOs and CBOs, along with a KCC contracted private company, collect household waste door to door on a daily basis, using rickshaw vans, in parts of several wards and then transport it to the SDS; these are considered to be effective operations, although only a minority of city dwellers receives this service. For the most part, householders take the waste to the SDS themselves or dispose of it indiscriminately.

Informal recyclers collect and dispose of the great majority of recyclable materials but this waste only constitutes a minority (around 20% by weight) of the total daily generated household waste. The great majority of household waste is bio-waste. Although there are some composting initiatives, their total output is negligible, 20-25 tons per month when compared to the average daily household waste generation of just less than 300 tons. Commercial waste is disposed of by individual enterprises. An NGO collects separated hazardous hospital waste around 1/3rd of Khulna’s health facilities but there is no system for its disposal.

It is currently estimated that only 50-60% of household waste is collected with most of the remainder being disposed of indiscriminately in drains, at roadsides and into vacant areas - a practice which exacerbates flooding. The major reasons for Khulna’s inadequate SWM system are: (1) the low managerial, technical and financial resources available to KCC to operate an effective SWM system; (2) the lack of public awareness and commitment by a large proportion of the population which leads to indiscriminate dumping of waste exacerbated by a resistance to NGO operated DtD services for which payments additional to the conservancy charges levied by KCC need to be made (ADB, 2009).

2.3 Compost

2.3.1 Definition

The controlled biological decomposition of organic solid waste under aerobic conditions called composting. Compost is the relatively stable decomposed organic material resulting from the composting process. It is also referred to as humus.

2.3.2 Quality of compost

Compost quality is a difficult to define and often elusive term, meaning different things to different people according to their professional background and national legislations. Nevertheless, compost quality lies at the core of the issue of composting and biological treatment in general, as it defines the marketing potential and the outlets of the product and in most cases, the viability of the treatment plant, but also the long-term acceptability of biological treatment as a valuable option in the waste hierarchy (Lasaridi, 1998).

Compost quality refers to the overall state of the compost in regard to physical, chemical and biological characteristics, which indicate the ultimate impact of the compost on the environment. The quality of compost is determined by the sum of its different features and properties; specifications are usually determined by minimum admissible levels of required substances or maximum tolerable limits for unwanted ones (Hogg *et al*., 2002; de Bertoldi, 1993). The criteria that are relevant to the evaluation of quality depend on what purpose the compost is used for, the relevant environmental protection policies and the market requirements (Gillett, 1992; Kehres, 1992). For example, composts intended as growing media should meet more stringent quality criteria compared to composts that will be used as landfill cover.

A number of characteristics determine compost quality, such as particle size distribution, moisture, organic matter and carbon content, concentration and composition of humus-like substances, nitrogen content and forms of N, phosphorus and potassium, heavy metals, salinity and the nature of ions responsible for it, cation exchange capacity, water holding capacity, porosity and bulk density, inert contaminants, pathogens, and state of maturity or stability (Lasaridi, 1998).

However, the most important, from the point of view of standards for the protection of public health, the soil and the environment in general, are those relating to pathogens, inorganic and organic potentially toxic compounds (heavy metals, PCBs, PAHs, phthalates etc.) and stability, the latter determining compost nuisance potential, nitrogen immobilization and leaching and phytotoxicity (Hogg *et al*., 2002; Brinton, 2000; Deportes *et al*., 1995).

Currently, compulsory and voluntary compost standards in different countries are characterized by a great degree of heterogeneity, stemming from the effort to combine two often contradicting targets: maximum environmental and public health protection on the one hand and maximum organic matter recycling on the other. Moreover, the precautionary approach adopted in the EU and the risk assessment approach prevailing in the USA, may lead to broad differences in the accepted limit values for a number of critical parameters, such as heavy metals (Hogg *et al*., 2002).

Even within the EU there is a wide variation among the limit values adopted by the member countries, with the north being usually more stringent than the south, reflecting mainly the varying level of progress on source separation of the biodegradable fraction of MSW, but also the different needs in soil organic matter. The adoption of the long debated ‘biowaste directive’ would alter this situation, leading to a more homogeneous European market for composted products. However, the delivery of a stand-alone ‘biowaste directive’ is currently uncertain and the discussion for including relevant standards and targets in a framework directive, such as a ‘soil framework directive’ or the revision of the waste framework directive is still at a preliminary level. All national compost standards include compost sanitization criteria for human pathogens and occasionally for plant pathogens. These criteria may refer to the product (absence of Salmonella, absence or low levels of fecal coli forms and fecal streptococci), the process (setting a minimum period for which the compost should maintain a temperature higher than a designated level) or both. Maximum permissible values are set for heavy metals (Cd, Cr, Cu, Hg, Ni, Pb, Zn) although the limits vary widely (Hogg *et al*., 2002; Deportes *et al*., 1995).

Similar values are set for foreign matter (glass, plastics and stones) in most national specifications, usually defined as maximum allowed content on a dry weight basis and in reference to their particle size (Hogg *et al*., 2002; Brinton, 2000). The degree of compost stability and its nitrogen content are particularly important for its agronomic use and are increasingly more often defined in compost specifications. Compost stability is no longer defined as the C/N ratio, as was often the case in older standards, but usually on the basis of compost microbial activity measured through the respiration activity (e.g. AT4, Dynamic Respiration Index, SOUR) or the self-heating potential (Rottegrade) (Hogg *et al*., 2002; Lasaridi and Stentiford, 1998; FCQAO, 1994).

2.4 Compost and sustainability of solid waste management

2.4.1 Principles of sustainable and integrated solid waste management

The modern concept of sustainability is based on the integration of three dimensions: the ecological dimension, the economic dimension and the socio-cultural dimension. The activities of our societies today must therefore be based on the goal that the ecological, economic and socio cultural development of future generations has the same potential as today. For example, the consumption of natural resources by today's societies must not lead to deficiencies for future generations. In this context, besides the rate of consumption and the proposed availability of natural resources also the demographic development and technological innovation potentials are important parameters for the adequate prognosis of a sustainable development (Zhu *et al*., 2008).

A more systematic way of thinking and looking at waste management is provided by an approach called sustainable and integrated solid waste management (Cointreau, 2001). Sustainable and integrated SWM puts into a focal matrix the urgent planning aspects including the environmental, socio-cultural, institutional, political, and legal aspects as well as the important role of stakeholders (rag pickers, the informal recycling sector, small-scale enterprises, women heads of household) and the other elements of the waste management system, such as prevention, reuse and recycling, collection, street sweeping, and disposal. Sustainable and integrated SWM is an integral part of good local governance because it is one of the most visible urban services influencing local perceptions of governance. It is conducted in a transparent and accountable manner to minimize opportunities for corruption and unwarranted political interference. Based on the principle of equity, integrated SWM provides a minimum level of acceptable service to all urban residents and establishments and is responsive to the service levels and conditions desired by those residents and establishments, with higher levels of service where there is either a greater need (for example, in terms of business development or tourism) or a greater desire to pay for a higher level.

Sustainable and integrated SWM recognizes that willingness to pay is affected by perceptions of the service quality received and by the involvement of stakeholders in decision making; it therefore places a high priority on keeping stakeholders informed about and involved in issues and proposals. Furthermore, it looks for ways to enable communities to be responsible and for individuals to take action in ways that build public cooperation with the service. Sustainable and integrated SWM is open to all viable parties, including women and microenterprises that can contribute to the economic provision of services. It also allows for the flexible service levels and conditions desired by the residents and establishments receiving service. Sustainable and integrated SWM provides workers with uniforms and safe working conditions and defines clear collection routes and verifiable performance tasks and outputs. To do so, it establishes management information systems that enable cost-effective accounting and overall cost-related performance monitoring.

Sustainable and integrated SWM provides economical service delivery and establishes cost-recovery mechanisms for long-term sustainability. A modern SWM program can be implemented for a reasonable cost. This fact is important because there are ample numbers of developing countries where SWM costs are high and the level of service low. But if the underlying reasons for these situations are analyzed, one can see in many cases that cost-effective waste management systems would result if the deficiencies identified in the systems were remedied.

To provide economic service delivery, sustainable and integrated SWM considers:

(a) Decentralized or bundled services as needed to optimize such economies;

(b) Comprehensive cost analysis and planning for continuous rationalization of routing, crew sizes, and technologies; and

(c) Selection of systems and equipment according to local conditions and preventive maintenance of vehicles and facilities.

Sustainable and integrated SWM ensures cost recovery through a range of revenue sources, including direct fees, indirect general taxes, and revenues from recycling and resource recovery. Furthermore, it establishes tariffs that ensure cost recovery but are adapted according to the ability to pay, the service provided, and the level of waste pollution generated. Segregated accounts for solid waste revenues further ensure that a reliable cash flow is available to meet service needs.

Sustainable and integrated SWM minimizes resource use and environmental impact. It is conducted in an environmentally conscientious manner that conserves natural resources and recovers waste where appropriate. For all equipment required by the service, including vehicles, machines, and parts, sustainable and integrated SWM encourages the use of indigenous manufacturing capacity. It also provides incentives for waste minimization, recycling, and resource recovery at source or as near to the source as possible. Sustainable and integrated SWM optimizes segregation of recyclable materials at the source of waste generation and encourages the development of markets for recyclable materials in major centers of waste generation, including incentives for increased industrial demand for secondary materials as feedstock.

Sustainable and integrated SWM involves environmental impact assessment and public involvement for all new transfer, treatment, and disposal facilities, and it ensures that those facilities are designed to meet environmentally cost-effective discharge and impact standards. It monitors the emissions and environmental changes related to all waste storage, handling, and disposal activities and uses systems to track and document hazardous waste. Those systems ensure that significant quantities are not mixed with other waste but are instead taken to secure facilities for treatment and disposal.

Sustainable and integrated SWM embraces public participation: planning and operations are participatory and enable continuous feedback from those involved in receiving and in providing service. It sensitizes the public to environmental issues, occupational health and safety issues, waste minimization opportunities, and the values of recycling and resource recovery.

Sustainable and integrated SWM builds institutional capacity. Adequate local authority and autonomy is provided to enable good municipal governance of the solid waste sector and self-sustainable financing and cost recovery. Sustainable and integrated SWM also allows local governments to enter multiyear private sector arrangements that match periods of depreciation for investments and that strengthen local capacity in planning, operation, and rationalization of operations (Zhu *et al*., 2008).

2.4.2 Environmental advantages of compost

The use of MSW compost in agricultural and horticultural operations has a number of benefits to the environment. They include:
Waste diversion Converting MSW into healthy compost which can be used to improve the productivity of agricultural and horticultural enterprises has a huge potential to divert household waste away from diminishing landfill resources. The community benefits are numerous:

- Reduced land-fill area requirements in urban areas
- Reduced greenhouse gas emissions caused by organic material decomposing in land-fill
- Less environmental impact from leachate entering underground water resources under land fill zones
- Land previously zoned for landfill can be freed up for more productive uses
- Reduced costs associated with transporting MSW to landfill zones further and further away from the generating sources.

By converting MSW into a value added product such as compost for use on farms, we as a community are returning organic matter back to the land and “completing the organic matter loop”. Fertilizer leaching: Applying compost to soils can aid in reducing the amount of fertilizer leaching from soils (Edmeades, 2003) which has two main benefits: fertilizers are held in the root zone where they can be taken up by the plant which increases the efficiency of use of applied fertilizer; and a reduction in the amount of fertilizer potentially polluting ground water resources. Moisture retention: Additions of compost increase a soils ability to retain moisture in a plants root zone which leads to greater crop performance and better irrigation water use efficiency. By holding moisture in the root zone the incursion of salty subsurface water can be minimized. This limits the damage to crop production that occurs with salt incursion.

Ameliorate salinity: The area of productive land adversely affected by rising salinity levels is rising dramatically. The use of compost to ameliorate soil salinity has potential as additions of organic matter into soil increases water infiltration and the potential for salt to be displaced from the root zone, and had been linked to improved soil structure and aggregation (Oades, 1984; Tisdell and Oades, 1982). Humic substances and humic carbon (components of compost) have also been shown to reduce the effect of salt on the germination and growth of certain species of plants. If the benefits of using MSW compost on salt affected land could be demonstrated, it would open up a huge new market for this material and provide farmers with a valuable management tool to reclaim areas of currently non productive or marginal land. Significant interest was expressed by several local land care groups to trial compost on salt affected pasture paddocks but limitations on available trial sites during the course of the project prevented this from occurring.

Organic matter management or composting means the application of residual organic matter such as compost or sewage sludge (bisolids) to improve soil properties or to accelerate pedogenesis. However, this soil treatment option must always aim at the improvement of at least one soil function (i.e. regulation function, transformation function, production function) and at the same time must not impair any of these soil functions (Akter, 1997).

1. It will not destroy the natural environment/ ecosystem,
2. This type of farming will increase the health of the natural environment. Specifically it will;

- Increase the self fertility of soil (regenerative nature),
- ·Increase soil micro fauna and flora i.e. biodiversity,
- Result in better quality food,
- Improve the health of consumers,
- Restore the native variety of crops and reduce the use of external high yielding variety (HYV) plants,
- Reduce pests and diseases of crops,
- Restore the ecological balance of the nature.

3. It will be sustainable,
4. Production capacity will be equal or higher and production costs will be lower than chemical agriculture,
5. It will have less dependence on external input than chemical agriculture. Specifically, it requires:

- No machines, i.e. no cultivation,

- No weeding by tillage or herbicides. Weed should be controlled not eliminated,
- No dependence on chemicals,
- No need to hold water for rice fields throughout the growing season.

6. This method of farming requires less labor and does not require the use of fossil fuels (Maria, 1996; PROSHIKA, 1995)

CHAPTER THREE
STUDY AREA AND METHODOLOGY

3.1 Study area

3.1.1 Location of the study area

Bangladesh, being a flood plain delta, is sloping gently from the north to the south, meeting the Bay of Bengal at the southern end. In between the vast land area numerous numbers of rivers, their tributaries and canals crisscrossed the whole landscape, particularly in the coastal region. The whole coast runs parallel to the Bay of Bengal, forming 710 km long coastline. The coastal zone covers 47,201 square kilometer land area, which is 32 percent of total landmass of the country (Islam, 2004). The coastal region of Bangladesh is one of the most vulnerable regions due to frequent disaster events, climate anomalies and human intervention causing a changing local environment in recent years. The study area is located in the vulnerable coastal areas of Bangladesh. The present study focuses on *Kharnia Union* under *Dumuria Upazila*, Khulna Districts in the South-Western coastal part (Figure 3.1). Large scale agricultural transformation has been taking place in this area, which is located not far away from the main city of Khulna (Miah *et al*., 2009). The study area, *Kharnia union* is located between 89.20° to 89.24°E and 22.48° to 22.52°N. The area is very close to *Dumuria upzila*. The distance of *Kharnia union* from Khulna city is about 35-40 km.

3.1.2 Socio-economic characteristics

The total population of the study area is 24503; where male 51.12%, female 48.88%. Among this population Muslim are 56.97%, Hindu 42.83%, Christian 0.01%, Buddhist 0.01%, and others 0.09%. Main occupations are agriculture 46.29%, agricultural laborers 16.77%, wage laborers 4.09%, commerce 12.85%, industry 2.01%, transport 3.24%, service 4.66% and others 10.08%. Total cultivable land is 2940 hectares, fallow land 324 hectares; single crop 36.52%, double crop 33.82%, treble crop 29.66%. Land control Among the peasants 20% are landless, 28% small, 32% intermediate, and 0.8% rich; cultivable land per head 0.12 hectares. Main crops are paddy, jute, vegetables (Banglapedia, 2006).

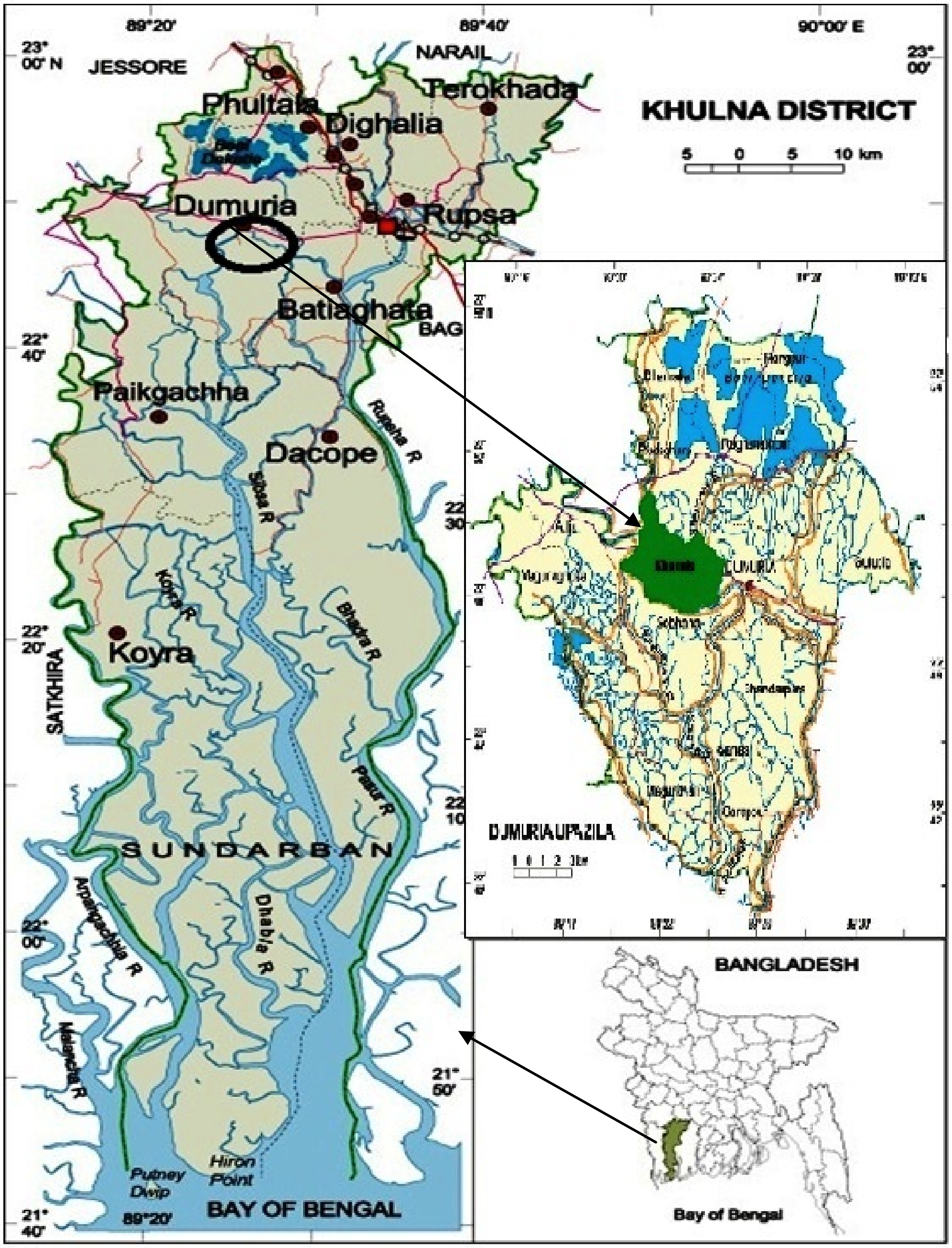


Figure 3.1: Location of the study area.

3.2 Methodology

The study was adopted both primary data and secondary data. Primary data was collected from direct field surveys, whereas secondary data was collected from available relevant literature. Focus group discussion (FGD) was conducted with the farmers of *Khornia Union* under *Dumuria Upazila* as the farmers have the experience regarding the use of compost in their agricultural lands. Five FGDs were conducted (where both FGDs duration is 30 to 40 minutes) to get farmers' opinion towards using compost, usefulness of compost and compost sale/marketing model. During FGDs, the interest of using compost by farmers, composition of compost, agricultural productivity due to uses of compost and compost selling market mechanism/model were discussed to get their opinions.

As proper quality and pricing are the key factors for compost marketing efforts, 100 questionnaire interviews among the farmers of *Kharnia Union* of *Dumuria Upazila* were conducted to assess the pricing of compost by farmers and to get their attitude towards compost usage. Finally, the outcomes of the survey were interpreted in the report.

CHAPTER FOUR
RESULT AND DISCUSSION

4.1 Socio-economic characteristic of the respondents

Male farmers for interviews were selected because they are mainly dominated in the country agriculture. Table 4.1 shows that agriculture is dominated by the age range of 36-45 years (33%) and 46-55 years (21%). The result indicates that majority of the farmers are about middle aged. The education qualification of the farmers is primary education (36%), SSC (29%), HSC (9%) and 25 percent are illiterates. The level of educational attainment is sufficient to support adoption of compost use through information sharing and distribution.

Response on farming experience shows that 40% of the farmers have between 16 and 25 years experience, while only 7% have less than 5 years experience. About 33% and 20% have experience 6 to 15 years and above 25 years respectively. The result shows that most of the farmers have been in farming profession for quite some period of time and are not novices in farming activities. The table further reveals that virtually all the respondents are small scale farmers having between 0.5 hectares to slightly above 2.0 hectares. Majority (41%) have income level ranging between Tk. 5,000 to 10,000, 36 percent have income level between Tk. 10,000 to 15000 while only 13 percent have above Tk. 20,000 and 10% had income level below Tk. 5000.

Table 4.1: Distribution of respondents by socio-economic characteristics (N = 100)

Variables	**Frequency**	**Percentage (%)**
Sex:		
Male	100	100%
Female	0	0%
Age:		
25-35	27	27%
36-45	33	33%
46-55	21	21%
56-65	11	11%
>65	8	8%
Education:		
Illiterate	25	25%
Primary education	36	36%
SSC	29	29%
HSC	9	9%
>HSC	1	1%
Farming Experience (Years):		
0-5	7	7%
6-15	33	33%
16-25	40	40%
25>	20	20%
Agricultural Land Size (Hectares):		
<0.5	56	56%
0.5-1.0	17	17%
1.0-1.5	15	15%
1.5-2.0	9	9%
>2.0	3	3%
Income Level (Tk):		
<5000	10	10%
5000-10000	41	41%
10000-15000	36	36%
>15000	13	13%

(Source: Field survey)

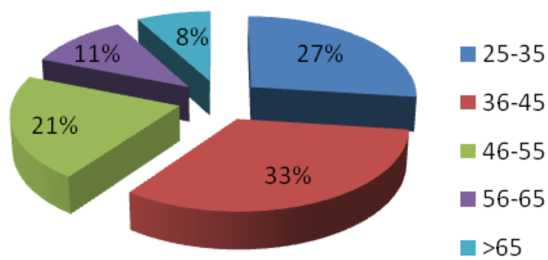


Fig:4.1 Age of the survey respondents (years)

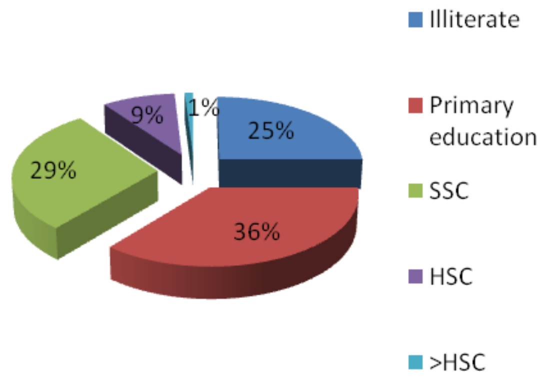


Fig: 4.2 Educational status of the survey respondents

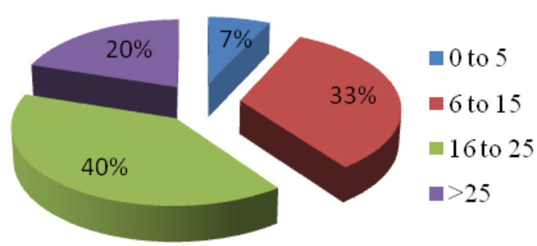


Fig: 4.3 Farming experience of the survey respondents (years)

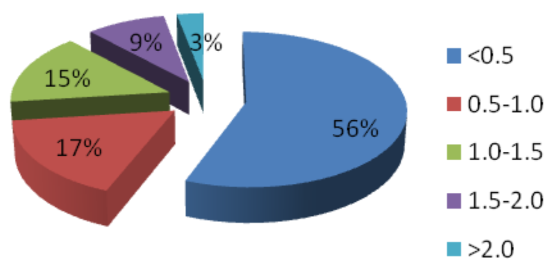


Fig: 4.4 Agricultural land size of the survey respondents (hectare)

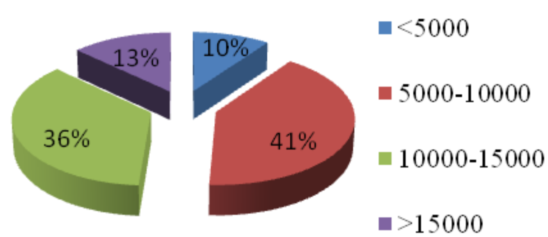


Fig: 4.5 Income level of the survey respondents

4.2 Farmers' level of general knowledge of compost use

About 90% farmers said that they used compost in their agricultural field. But only 32% farmers used KCC generated compost in their agricultural land. Low availability of compost (37%) and lack of information about compost (51%) are the main reason for less use of compost in their agricultural land. Only 11% farmers said that chemical fertilizer works better than compost. Most of the farmers of the area said that no hazard occurs when they use compost in their agricultural field, only 4% said that hazards involved during compost use in their land. Only 4% said that they take precaution during compost uses in their agricultural land. Table 4.2 (a) showed the frequency and percentage of farmers' level of general knowledge of compost use.

Table: 4.2 (a) Farmers' level of general knowledge of compost use

Knowledge	Perception	Frequency	Percentage
Different types of compost	Cow dung	64	64
	KCC solid waste generated compost	32	32
	Other type of compost	4	4
Compost use intensity	Very low	17	17
	Low	16	16
	High	56	56
	Very high	11	11
In which crop compost is used more	Rice	37	37
	jute	7	7
	vegetable	56	56
Use fertilizer with compost	Very low	8	8
	Low	53	53
	High	24	24
	Very high	15	15
Why use chemical fertilizer	Lack of information about compost	51	51
	Quality of compost is low	1	1
	Availability of compost is low	37	37
	Chemical fertilizer works better	11	11
Hazards involved in compost use	Very low	20	20
	Low	70	70
	High	4	4
	Very high	0	0
Precautions before application	Very low	29	29
	Low	67	67
	High	4	4
	Very high	0	0

Most of the farmers said that the cost of compost is low. According to them, the compost price varied between Tk. 5-10 per kg when they bought it. 37% farmers said that they purchased compost at a price of Tk. 5 per kg and only 12% said that compost price is Tk. 10 per kg. It showed that compost prices vary. The average cost of compost is about Tk. 7 per kg, while maximum and minimum costs were Tk. 10 and 5 per kg respectively. Table 4.2 (b) showed the frequency and percentage of farmers' level of general knowledge about cost of compost and Table 4.2 (c) showed the mean, maximum, minimum and standard deviation of farmers' level of general knowledge about cost of compost.

Table 4.2 (b): Farmers' level of general knowledge about cost of compost

Knowledge	**Cost of compost per kg (Tk.)**	**Frequency**	**Percentage**
Cost of compost	5	37	37
	7	32	32
	8	19	19
	10	12	12

Table 4.2 (c): The mean, maximum, minimum and standard deviation of farmers' level of general knowledge about cost of compost

	Statistical Parameter	**Unit (Tk per kg)**
Farmers' level of general knowledge about cost of compost	Mean	6.81
	Maximum	10
	Minimum	5
	Standard deviation	1.65

Moreover, it was found that, among the survey farmers, 56% farmers used 200 kg compost per hectare and only 11% farmers used 250 kg compost per hectare. 17% farmers used very low amount of compost in their agricultural field. Statistical analysis shows that on an average 181 kg per hectare compost was used in agricultural field, maximum and minimum value of compost use in agricultural field is 250 kg and 100 kg per hectare. Table 4.2 (d) showed the frequency and percentage of amount of compost use in agricultural field and table 4.2 (e) showed the mean, maximum, minimum and standard deviation of amount of compost use in agricultural field.

Table 4.2 (d): The frequency and percentage of amount of compost use in agricultural field

Knowledge	Amount of compost use (kg/hectare)	Frequency	Percentage
Amount of compost use in agricultural land	100	17	17
	150	16	16
	200	56	56
	250	11	11

Table 4.2 (e): The mean, maximum, minimum and standard deviation of amount of compost use in agricultural field

	Statistical parameter	Unit value (kg per hectare)
Amount of compost use in agricultural field	Mean	180.50
	Maximum	250
	Minimum	100
	Standard deviation	44.887

4.3 Farmers' attitude towards the use of compost

Among the survey farmers, 84% farmers said that compost generally increases crop production. Only 16% farmers were disagreed and think that compost do not increase crop production. But 88% farmers said that compost is useful in farming, 90% said that compost is necessary for crop growth. Almost all of the farmers said that by using compost the color and weight of the crop is increased. Table 4.3 (a) showed the frequency and percentage of farmers' attitude towards the use of compost.

Table 4.3 (a): Farmers' attitude towards the use of compost

Perceived attitude	Perception	Frequency	Percentage
Increased production cost	Strongly disagree	3	3
	Disagree	84	84
	Agree	13	13
Promotes weed growth	Disagree	52	52
	Agree	48	4 8
Not useful in farming	Strongly disagree	22	22
	Disagree	66	66
	Agree	12	12
Necessary for crop to do well	Disagree	10	10
	Agree	69	69
	Strongly agree	21	21
Increase crop yield	Strongly disagree	5	5
	Disagree	11	11
	Agree	71	71
	Strongly agree	13	13
Does not impair with quality of produce	Disagree	16	16
	Agree	81	81
	Strongly agree	3	3
Loss for compost use	Strongly disagree	14	14
	Disagree	75	75
	Agree	11	11

Moreover, 61% farmers said that rice production increased by 200 kg/hectare due to compost uses in their agricultural field. About 42% farmers said that vegetable production increased by 320 kg/hectare due to compost uses in their agricultural land and 32% said that vegetable production increased by 280 kg/hectare. Statistical analysis shows that on an average rice production increased by 201 kg per hectare and on an average vegetable production increased by 310 kg per hectare. Table 4.3 (b) shows the increase in rice and vegetable production due to compost use and Table 4.3 (c) shows the mean, maximum, minimum and standard deviation of the amount of rice and vegetable production.

Table 4.3 (b): The amount of rice production and vegetable production increased by using compost

Perception	Kg per hectare	Frequency	Percentage
Amount of rice production increased	120	5	5
	140	4	4
	160	6	6
	180	2	2
	200	61	61
	220	7	7
	240	8	8
	280	7	7
Amount of vegetable production increased	200	9	9
	280	32	32
	320	42	42
	400	17	17

Table 4.3 (c): The mean, maximum, minimum and standard deviation of the amount of rice production and vegetable production increased by using compost

	Statistical parameter	Unit value (kg per hectare)
Amount of rice production increased	Mean	201
	Maximum	280
	Minimum	120
	Standard deviation	34.392
Amount of vegetable production increased	Mean	310
	Maximum	400
	Minimum	200
	Standard deviation	53.143

4.4 Constraints to compost use

Availability of compost and lack of good compost marketing system are major constraint for compost use. Farmers think that lack of capital is another constraint for compost production and marketing system. 86% farmers said that information about KCC solid waste generated compost is not sufficient for them. Table 4.4 (a) shows the frequency and percentage of constraints to compost use.

Table 4.4 (a) Constraints to compost use

Constraints	Perception	Frequency	Percentage
Availability of compost	Serious	77	77
	Very serious	23	23
Lack of good compost marketing system	Disagree	3	3
	Agree	66	66
	Strongly agree	31	31
Low durability of produce	Strongly disagree	1	1
	Disagree	37	37
	Agree	62	62
Lack of capital	Disagree	10	10
	Agree	80	80
	Strongly agree	10	10
Inadequate information	Disagree	14	14
	Agree	57	57
	Strongly agree	29	29
Inadequate training about compost	Agree	62	62
	Strongly agree	38	38

4.5 Usefulness of compost

Hoornweg *et al*., 1999 noted that compost have many useful application. These are:

- Increases overall waste diversion from final disposal, especially since as much as 80% of the waste stream in low- and middle- income countries is compostable.
- Enhances recycling and incineration operations by removing organic matter from the waste stream.
- Produces a valuable soil amendment—integral to sustainable agriculture.
- Promotes environmentally sound practices, such as the reduction of methane generation at landfills.
- Enhances the effectiveness of fertilizer application.
- Can reduce waste transportation requirements.
- Flexible for implementation at different levels, from household efforts to large-scale centralized facilities.

- Can be started with very little capital and operating costs.
- The climate of many developing countries is optimum for composting.
- Addresses significant health effects resulting from organic waste, such as reducing dengue fever.
- Provides an excellent opportunity to improve a city's overall waste collection program.
- Accommodates seasonal waste fluctuations, such as leaves and crop residue.
- Can integrate existing informal sectors involved in the collection, separation and recycling of wastes.

Almost all of the farmers said that the usefulness of compost is knows know bound. 93% farmers agreed that compost fertilizer increase soil fertility, 76% agreed that compost fertilizer enhances the effectiveness of other fertilizer application, 56% farmers agreed that less dependence on external input by using compost in agricultural and 82% farmers agreed that compost from KCC solid waste can improve city overall waste diversion and waste collection program. Table 4.5 shows frequency and percentage of usefulness of compost.

Table 4.5: Frequency and percentage of usefulness of compost

Usefulness	Perception	Frequency	Percentage
Increase soil fertility	Disagree	7	7
	Agree	79	79
	Strongly agree	14	14
Enhances the effectiveness of fertilizer application	Strongly disagree	1	1
	Disagree	23	23
	Agree	74	74
	Strongly agree	2	2
Less dependence of external input	Strongly disagree	1	1
	Disagree	43	43
	Agree	52	52
	Strongly agree	4	4
Increase overall waste diversion	Disagree	18	18
	Agree	78	78
	Strongly agree	4	4

4.6 Quality of compost

Compost quality refers to the overall state of the compost in regard to physical, chemical and biological characteristics, which indicate the ultimate impact of the compost on the environment. 62% of the farmers think that the quality of KCC generated compost is low and sometimes different objectionable ingredients is found in KCC generated compost such as, bone of different animals, fish etc. They also said that they will be interested to buy compost more if such constraints are overcome and the quality of KCC generated compost is improved by arranging proper training with knowledge sharing about compost uses in agricultural fields.

4.7 Development of compost marketing model

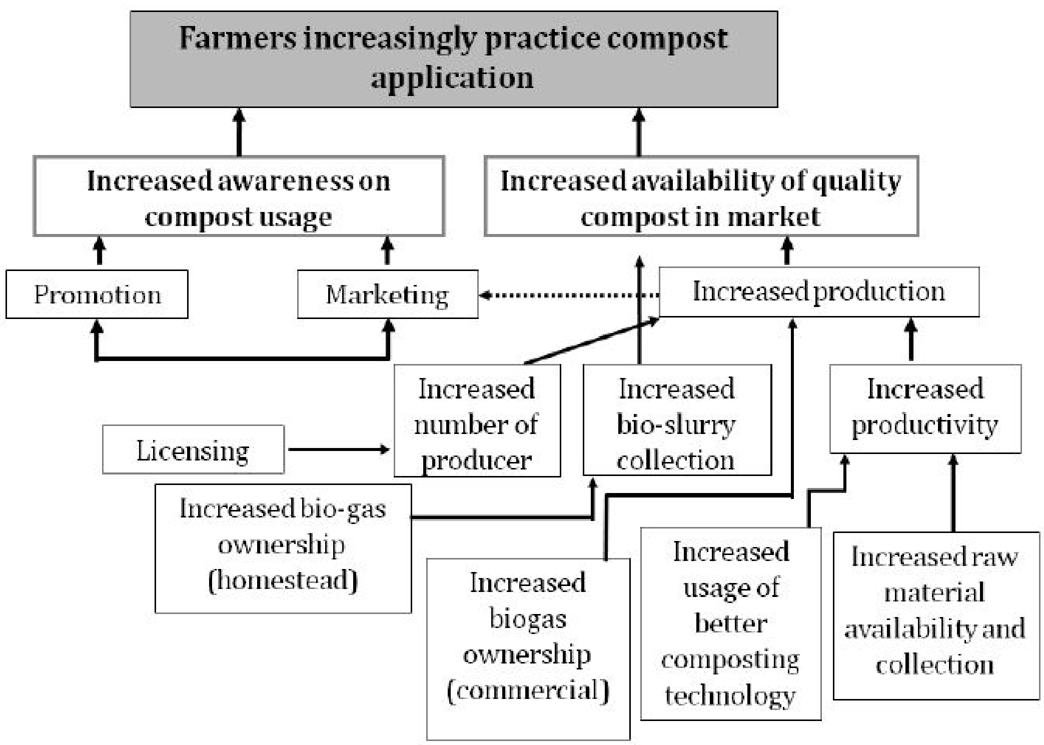


Figure 4.6: A sketch out of the prospects of increased compost usage and its market promotion in Bangladesh Agriculture (Rashid, 2011).

Experience shows that many previous composting projects have either focused on technological aspects of composting or social aspects in marginalized population groups. Much less attention is given to a detailed assessment of the market for compost in the respective regions. The importance of the interaction of product quality, price and customer demand is often underestimated. Hence, many projects failed due to the lack of a market for the product thus leading to financial problems, which could not be solved. The potential market for compost does not only determine the size of the plant but also the composting technique and the post-treatment of the compost, as potential customers have specific needs for their application of compost. Hence, to ensure sustainability of the composting scheme, market analysis and the market development should begin before the product is produced.

The demand for the compost product can be influenced by various factors, some of which are listed below.

- The current use of organic municipal waste (e.g. life stock farming, fertilizer, soil blending);
- The customer segments (e.g. agriculture and horticulture, public agencies, land reclamation, etc.);
- The type and place of application;
- Perceptions of existing and potential customers towards compost and their knowledge about compost use;
- The potential demand and seasonal variation;
- The required quality of compost;
- The availability of competitive products (e.g. cow and poultry manure, wastes from agro-industries, or chemical fertilizers).

An appropriate compost marketing and distribution strategy takes all these factors into consideration. Two main distribution strategies for compost can be described as:

- Direct compost marketing to end users or
- Compost marketing through a retailer or bulk supplier.

Which distribution strategy to use, depends on the existing resources for transport, which in the most cases is the limiting factor as many decentralized and community-based projects do not have the means for transportation. Transportation costs add to the product price thus automatically restricting the distance of distribution (Zurbrugga *et al.*, 2004).

In the study area most of farmers (73%) said that they need direct compost market which means they wants to buy compost from the producer. The people of the survey area think that if producers sell their product directly to farmer then the price of the compost will be lower and the quality of compost may be much better than market compost, which is suitable for their farming. By taking into account the farmers' perception, direct compost marketing model and indirect compost marketing model were developed and is shown in figure 4.7.

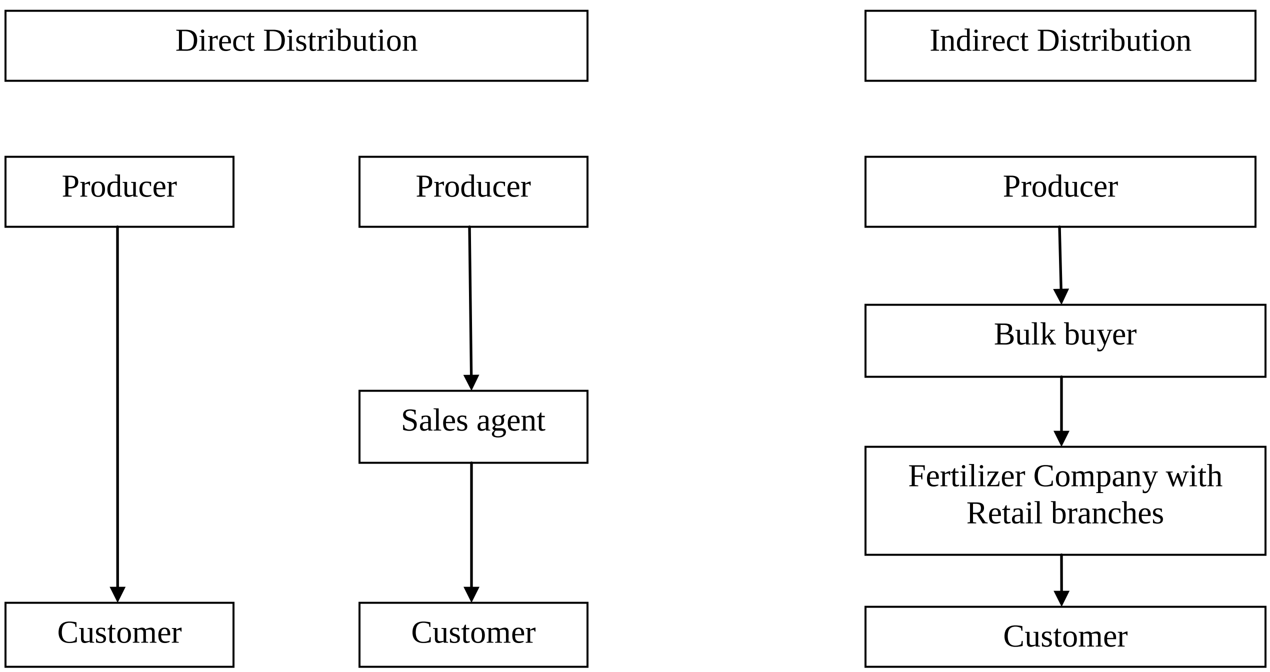


Figure 4.7: Compost Sales and Distribution Models

4.8 WTP assessment for compost

All of the farmers are willingness to buy compost. They wanted to increase their crop production, soil fertility and also wanted to improve overall waste diversion and collection program in Khulna city by using compost which is generated from KCC solid waste. For these reasons, farmers are wanted to willingness to buy KCC solid waste generated compost. They said that if the quality of compost is better and they get more information about compost, they will buy compost willingly. It is found that 15% of the farmers are willingness to buy compost at a rate of Tk. 10 per kg, 44% at a rate of Tk. 15 and 33% at a rate of Tk. 20. Only 8% farmers were wanted to buy compost at a rate of Tk. 20 per kg. Statistical analysis shows that farmers are willing to buy KCC compost at a rate of approximately Tk. 16 per kg. Table 4.8 (a) shows willingness to pay assessment for compost and Table 4.8 (b) showed mean, maximum, minimum and standard deviation of WTP.

Table 4.8 (a): Willingness to pay assessment for compost

WTP	Amount (Tk.) per kg	Frequency	Percentage
Willingness to pay assessment for compost	10	15	15
	15	51	51
	20	34	34

Table 4.8 (b): Mean, maximum, minimum and standard deviation of WTP

WTP	Statistical parameter	Unit value (Tk. per kg)
Willingness to pay assessment for compost (Tk. per kg)	Mean	15.95
	Maximum	20
	Minimum	10
	Standard deviation	3.385

CHAPTER FIVE
CONCLUSION

5.1 Conclusion

Compost is the end product of decomposition of MSW (organic matter). Generally, compost is not rich in essential nutrient constituents but it is importantly considered as a soil conditioner and used for balanced fertilization in agricultural crop production. Farmers in Bangladesh mostly rely on chemical fertilizers for higher production without or less application of compost. Despite huge potential, compost sector in Bangladesh is facing three major constraints: complicated and time-consuming licensing procedure, weak market demand for composting technology; and lack of awareness among farmers on benefits of using compost. However, compost has a high market potential considering the challenge of motivating farmers' attitude towards its increased usage through a strengthened demand-driven supply channel. Compost marketing and production may be the sustainability indicator for MSW management.

However, the results of the study show that about 90% farmers said that they used compost in their agricultural field. But only 32% farmers used KCC generated compost in their agricultural land. Low availability of compost (37%) and lack of information about compost (51%) are the main reason for less use of compost in their agricultural land. Only 11% farmers said that chemical fertilizer works better than compost. Most of the farmers said that the cost of compost is low. According to them, the compost price varied between Tk. 5-10 per kg when they bought it. 37% farmers said that they purchased compost at a price of Tk. 5 per kg and only 12% said that compost price is Tk. 10 per kg. It showed that compost prices vary. The average cost of compost is about Tk. 7 per kg, while maximum and minimum costs were Tk. 10 and 5 per kg respectively. Moreover, 61% farmers said that rice production increased by 200 kg/hectare due to compost uses in their agricultural field. About 42% farmers said that vegetable production increased by 320 kg/hectare due to compost uses in their agricultural land and 32% said that vegetable production increased by 280 kg/hectare. Statistical analysis shows that on an average rice production increased by 201 kg per hectare and on an average vegetable production increased by 310 kg per hectare. The people of the survey area think that if producers sell their product directly to farmer then the price of the compost will be lower and the quality of compost may be much better than market compost, which is suitable for their farming. 62% of the farmers think that the quality of KCC generated compost is low and sometimes different objectionable ingredients is found in KCC generated compost such as, bone of different animals, fish etc. They also said that they will be interested to buy compost more if such constraints are overcome and the quality of KCC generated compost is improved by arranging proper training with knowledge sharing about compost uses in agricultural fields. It is found that 15% of the farmers are willingness to buy compost at a rate of Tk. 10 per kg, 44% at a rate of Tk. 15 and 33% at a rate of Tk. 20. Only 8% farmers were wanted to buy compost at a rate of Tk. 20 per kg. Statistical analysis shows that farmers are willing to buy KCC compost at a rate of approximately Tk. 16 per kg.

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