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Adoption of Vermicomposting for Sustainable Solid Waste Management and Agricultural Production

K. M. D. Hossain^a, B. Roy^{a,b}, Suman C. Mohanta^c and M. R. Mia^a

^a Department of Environmental Science and Technology, Jessore University of Science and Technology, Jessore-7408, Bangladesh,

^b Department of Environmental Science and Geography, Islamic University, Kushtia-7003, Bangladesh

^c Department of Chemistry, Jessore University of Science and Technology, Jessore-7408, Bangladesh

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ABSTRACT

Key Words:

Agricultural Production,
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The study was conducted to observe the present management practices of organic waste to produce organic fertilizer and the ultimate outcomes to improve the socioeconomic condition and the agricultural production of Niamotpur, Kaligang Upazila, Jhenaidah. From the study 70% respondents are producing vermicompost from organic waste. It takes about 40-45 days to convert vermicompost from organic waste and is an easy process to convert and manage the biodegradable organic waste. The vermicompost use intensity in the study area is high due to the hazardous impact and high price of chemical fertilizer whereas the vermicompost is really low in price and free from all hazardous impact. Vermicompost can be used for all kinds of crops. By applying this technology, the village people had changed their total socio economic conditions than the past. Farmers in this area are greatly benefited through vermicomposting. Before vermicomposting, unmanaged waste caused serious environmental problems and they suffer from various disease but their environment conditions is better now. Vermicomposting is compatible with sound environmental concepts that value sound conservation of resources and sustainable practices.

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I. Introduction

Vermicomposting is an eco-biotechnological process that transforms energy rich and complex organic substance into stabilized humus like product vermicompost. It is considered as an excellent product,

since it is homogenous and has desirable aesthetics. Further it has reduced level of contaminants and tends to hold more nutrients over a longer period without impacting the environment (Suthar and Singh, 2008). The organic portion of the solid waste which is highly organic in nature, have considerable potential value if it is converted into compost through composting (Kaviraj and Sharma, 2003). Composting is one method of utilization of organic waste to produce manure, rich in plant nutrient. The role of earthworms in improving soil fertility is well known. Earthworms feed on organic matter and excrete undigested matter as worm casts. Recently, there has been much emphasis on preparation of vermicompost by use of earthworms. So, vermicomposting has become an appropriate for the safe, hygiene and cost effective disposal of it (Singh *et al.*, 2011). Solid waste generated from agricultural activities such as crop residues and animal excreta require special attention for disposal as they are rich in organic matter and recyclable plant nutrients. Reuse of these waste after bioprocessing can supply nutrients in plants, improves the physical and chemical properties of soil and enhance its fertility (Bansal and Kapoor, 2000). Vermicomposting technology using earthworms as versatile natural bioreactors for effective recycling of organic wastes to the soil is an environmentally acceptable means of converting waste into nutritious composts for crop production (Edward *et al.*, 1985). It is a low cost technology system for processing and treatment of organic waste. The objectives of the study were (a) to measure the extent of vermicomposting among the farmers (b) to know farmer's attributes towards usefulness of vermicomposting in agricultural field as compared to chemical fertilizers (c) to ensure the sustainable solid waste management and agricultural production through vermicomposting.

II. Materials and Methods

The study was conducted at Niamotpur village and its surrounding villages in Niamotpur union of Kaligang Upazila under Jhenaidah district in Bangladesh. Niamotpur union is located between 23°36'N latitude and 89°15' E longitude. It is 3 km away from upazila head quarter and 19 km away from district head quarter. The study was conducted during January 2016 to June 2016.

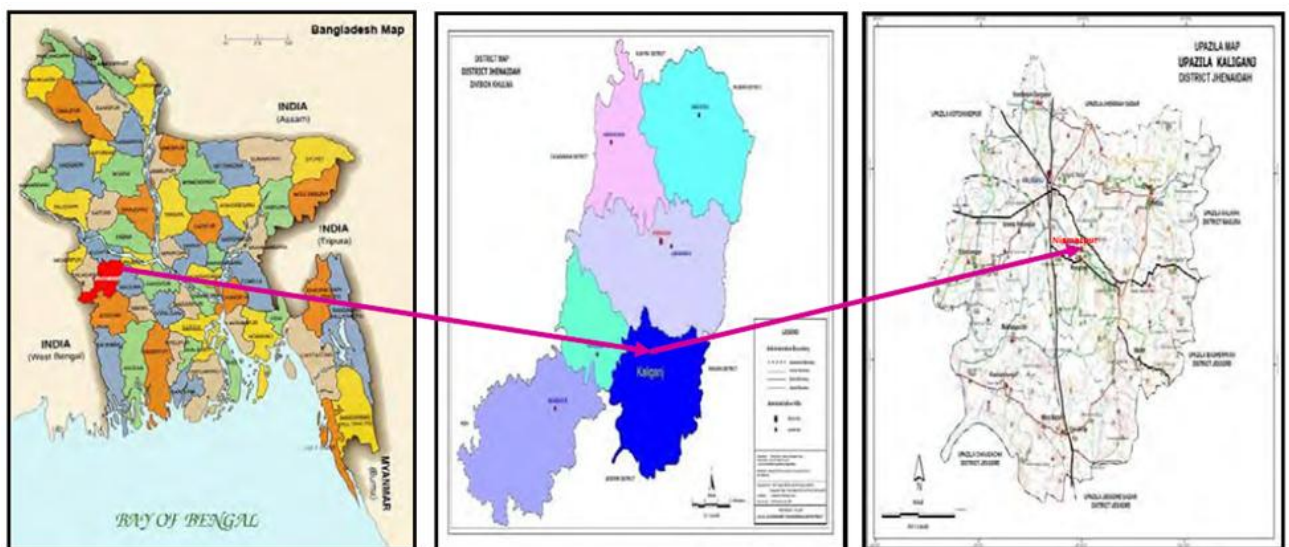


Figure 1. Map of Study area

Data collection, processing and analysis

Primary data are the data that are collected from research field. Primary data were collected by (a) Questionnaire survey (b) Observation of vermicomposting technology and (c) Photography. It has 38,339 households and a total area of 310.16 km². About 100 households were randomly selected for our research purpose. Secondary data were collected from different journals, reports, research papers, published and unpublished documents of Government and non-government office. Maps related to our study were collected from various offices of government and NGOs organizations.

Data processing

All the collected data were analyzed using computer by program. Statistical methods such as frequency count, average etc. were used for analysis. After collecting the secondary data efforts made for interpretation. After data processing the data was sorted for analysis.

Data input and analysis

The survey data have been edited and coded manually and processed by MS Excel 2010. Qualitative data have been manually inserted. Finally for data analysis MS Excel have been used and presented as table, bar diagram, pie chart etc.

III. Results and Discussion

Comparison based on construction of machine

The study was conducted in Niamotpur village and its surrounding village, Kaligang Upazila, Jhenaidah District in Bangladesh. About 70% respondents produce vermicompost from organic waste. They earn about 10,000-15,000 tk/month by selling this vermicompost. It takes to about 45 days to convert vermicompost from organic waste.

The percentage of using solid waste in the study area

In the past, maximum respondents used their waste as burning for cooking. They made dung stick from cow dung. It was observed that, in the past about 8% of the respondent preferred to burn their waste whereas only 5% of the respondent used waste for vermicomposting (Figure 2). About 12% respondent dumped waste here and there and about 50% of the respondents directly used normal compost in their field resulting in various environmental hazards. But recently, a larger portion of the respondents preferred to use their organic waste as vermicomposting. About 70% respondents of the study area produce vermicompost by vermicomposting technology. Now only 5% and 10% of the respondents are dumping and directly using the normal compost waste, respectively. Agricultural waste, horticultural waste, animal waste, silkworm litter, plant biomass (leaf litter), weeds, kitchen waste abiding, foul, acidic, spicy and spoilt food, city refuse after removing nondegradable waste material such as glass, plastic, strong rubber and metal can be vermicomposted (Kale, 1995).

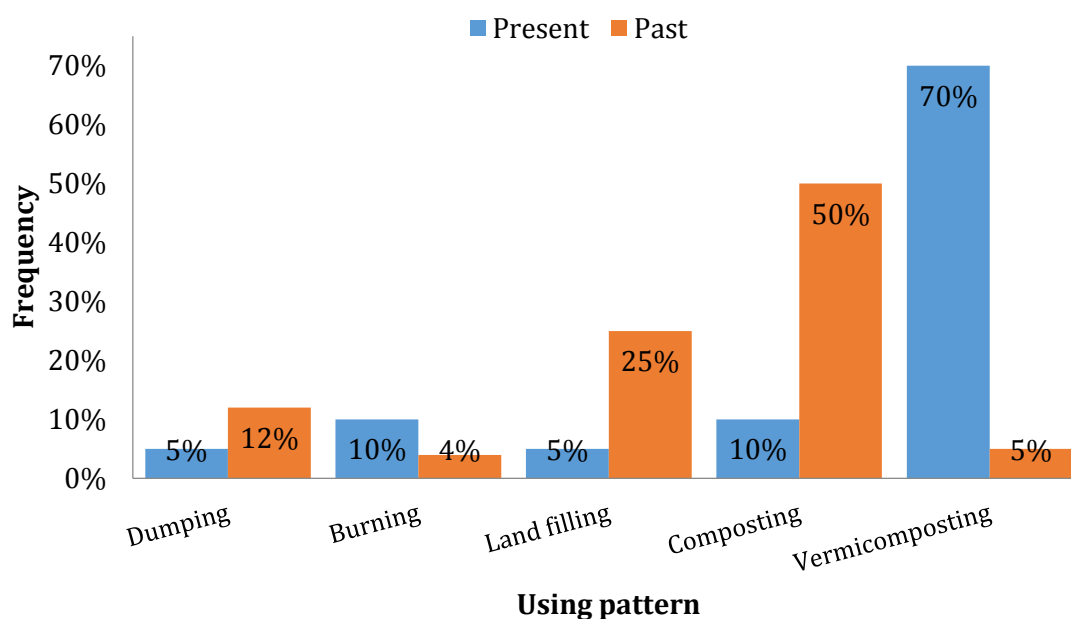


Figure 2. Present and past scenarios of using wastes

The perception of people about producing fertilizer from waste

Most of the people of the region mainly depend on agriculture. During the study, it was found that about 80% people of this region wished to produce fertilizer from the waste where only 20% was not interested to produce fertilizer from the waste (Figure 3).

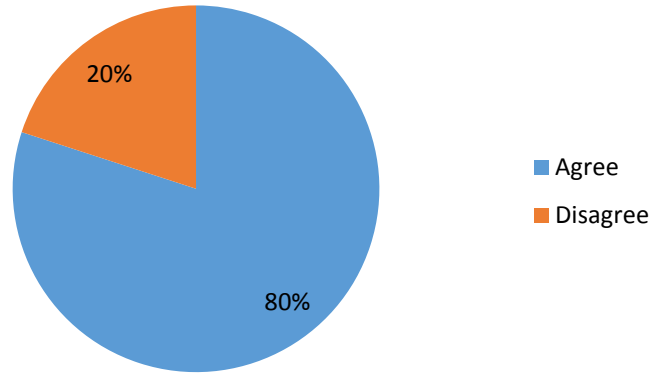


Figure 3. People’s perception about producing fertilizer from waste

Using pattern of vermicompost among the local people

Near 70% of the respondents produce vermicompost and rest 30% of the respondents do not produce vermicompost in the study area. Among the respondents about 54% of the respondents apply their vermicompost to the homestead lands and about 29% of the respondents apply their vermicompost to the agricultural lands. About 6% of the respondents use vermicompost for fishing feed and only 11% of the respondents enable to sell their vermicompost for earning money (Figure 4).

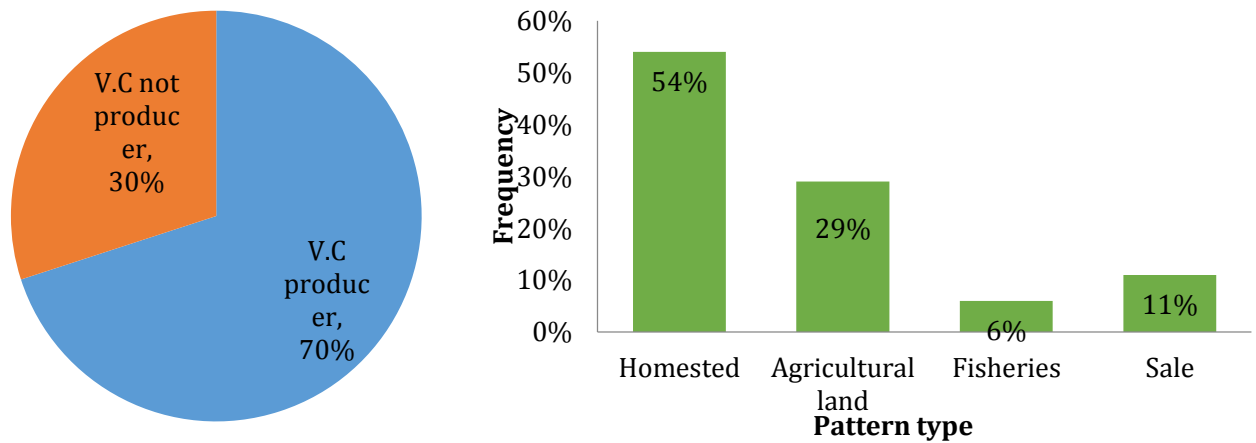


Figure 4. Vermicompost (VC) producer and Non producer

Percentages of producing VC with present and past scenarios

In this area about 5% of the respondents produced vermicompost in the past and about 70% of the total respondents are producing vermicompost at present (Figure 5)

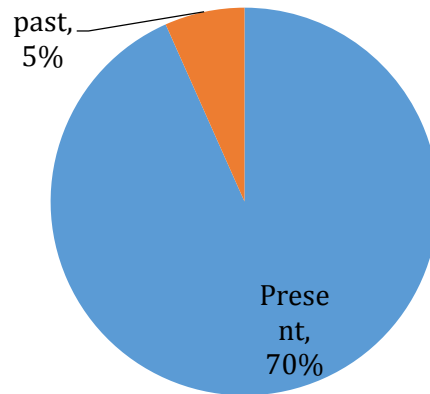


Figure 5. Present and past scenarios of vermicompost producers

The scenarios of increasing VCPs day by day in the study area

According to the local information of the study area the percentages of the vermicompost producer was likely to zero in the past. The percentages of vermicompost producers are increasing day by day. During 2001-2005 the percentages were increased at 5% and during 2006-2010 the percentages were increased at 45%. These were increased at 65% during 2011-2015 and from 2016 to till present the percentages has increased at 70% (Figure 6).

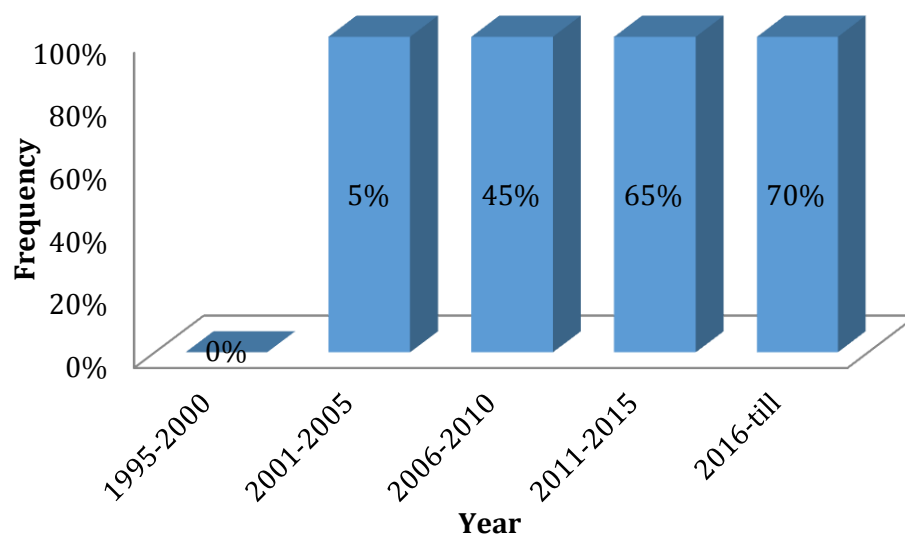


Figure 6. Increasing VC producer with time

Pollution reduction scenarios through Vermicomposting system

The local people of the study area have said that the total surrounding area of the houses, market, shops, ponds, streets, and open spaces were highly gathered with various solid wastes but now-a-days the volume has been decreased. Through adopting vermicomposting process the environmental pollution has been minimized. The minimization pattern is very much effective. The percentages of total minimization of dumping of waste are about 12%. The percentages of total minimization waste volume are about 80%. The percentages of odor are about 75%. The percentages of minimization water pollution are about 25% and the percentages of minimization of leachate are about 78% (Figure 7). The importance of vermicompost in agriculture, horticulture, waste management and soil conservation has been reviewed by many workers (Edwards, 1995). The studies revealed that use of vermicompost decreased pollutant concentrations in the soils (Pereira *et al.*, 2014). For example, vermicompost reduced pesticide concentrations in the presence of microorganisms. Similarly, vermicompost also reduced insecticide concentrations due to the presence of charged groups of

vermicompost surface. Vermicompost formed from olive cake and other organic substrates reduced herbicide concentrations after mixing with calcareous soils (DelgadoMoreno and Penã, 2009).

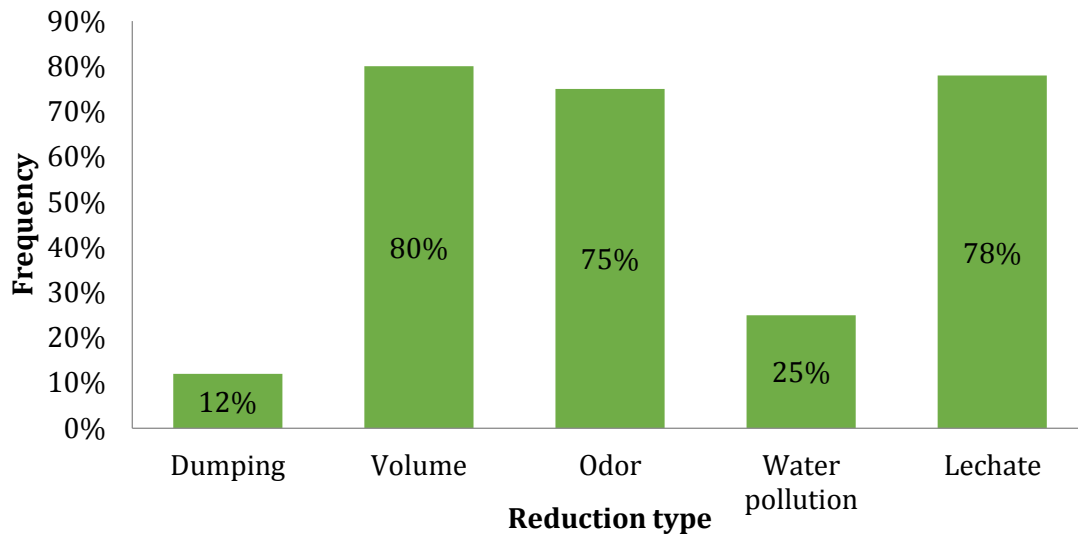


Figure 7. Pollution reduction scenarios through Vermicomposting system

Market value of Vermiproducts according to local people

The market value of vermicompost is high to the vermicompost producers. According to the local report of the study area, 70% of the respondents expressed that 40 kg of high quality vermicompost is about 500-550 Tk and 40 kg of lower quality vermicompost is about 350-400 Tk. But market value of earthworm is high. The local people have expressed that 3 kg of earthworm of *Esenia fedita* is about 10000 Tk and the percentages of the respondents were 50% and 20% of the respondents of the study area expressed that about 1 kg of earthworm species of *Esenia fedita* is about 1500-2000 Tk (Table 1). One Kg of vermicompost can be sold at Tk 10. The market price of earthworms is Tk 1500 – 2000 per Kg (Khan *et al.*, 2012). Vermicompost costs vary according to their quality, granule size, and packaging, ranging from 13,625 rupees to 68,125 rupees per ton (Bogdanov, 2013). In another case study in Uganda, the selling cost was 5.45 rupees per kilogram (Lalander *et al.*, 2015), signifying that vermicompost income depends on the market location. The vermicomposting process also produces revenue through the generation of surplus earthworm biomass, ranging from 340.75 rupees to 2,384.38 rupees per pound in the market (Bogdanov, 2013).

Table 1. Market value of vermiproducts

Vermiproducts	Amounts	Values	Percentages of the respondents
High quality vermicompost	40 kg	500-550 Tk	70%
Lower quality vermicompost	40 kg	350-400 Tk	
Earthworms	3 kg	10,000 Tk	20%
	1 kg	1500-2000 Tk	

Cost benefit chart of VC per 40 kg VC production

On the basis of that study about 42% of the respondents of the study area expressed that 40 Kg of vermicompost production cost is about 2170 Tk and the vermiproducts sale price is 4500 Tk. So the total benefit is about 2330 Tk. On the other hand about 28% of the respondents have expressed that 40 Kg of vermicompost production cost is about 2170Tk but the sale price is about 3400 Tk and the total benefit is about 1220 Tk (Table 2).

Table 2. Cost-benefit chart of vermicomposting system per 40 Kg production.

Waste materials cost (Tk)	Chari cost (Tk)	Earthworm cost (Tk)	Compost sale (Tk)	Earthworm sale (Tk)	Benefits (Tk)	Respondents (%)
150	20	2000	500	4000	2330	42%
130-150	30	2000	400	3000	1220	28%

People involved with different occupations in the study area

It was observed that people involved with different occupation in the study. So the patterns of socioeconomic conditions of the respondents vary depending on their occupation and various practices. Most of the respondents of the study area are farmers, some are housewives, some are students, some are government or nongovernment employees and the rest are engaged in various occupations (Table 3).

Table 3. Types of occupation of the respondents in the study area.

Primary occupation	Percentages (%)
Farmer	57%
Housewife	28%
Student	3%
Employee	4%
Others	8%

Household conditions of the study area

It was observed that about 22% houses are semi-pakka and about 73% houses are pakka at present. Almost 70% houses are involved in vermicompost production and they earn money. So the social status of the respondents had changed with time. At past maximum households was kacha or semi-pakka. About 62% households were kacha and about 6% households were pakka in the past. Figure showed the household conditions among the respondents in the study area. We found that the household status is being changed with time (Figure 8).

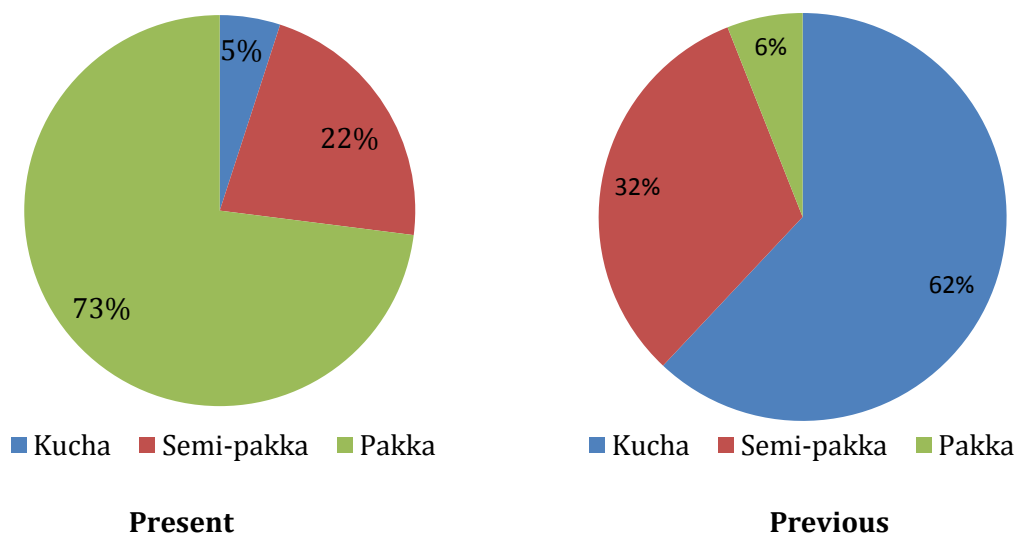


Figure 8. Previous household condition and present household condition

Number of composting bin of the people of the VCPs

It was observed that the respondents of the study area were involved in various occupations and their income vary with their occupation. The earthworms are considered in high price to the respondents of the study area. For that causes their chari number is less but the number vary upon the percentages of the respondents (Figure 9).

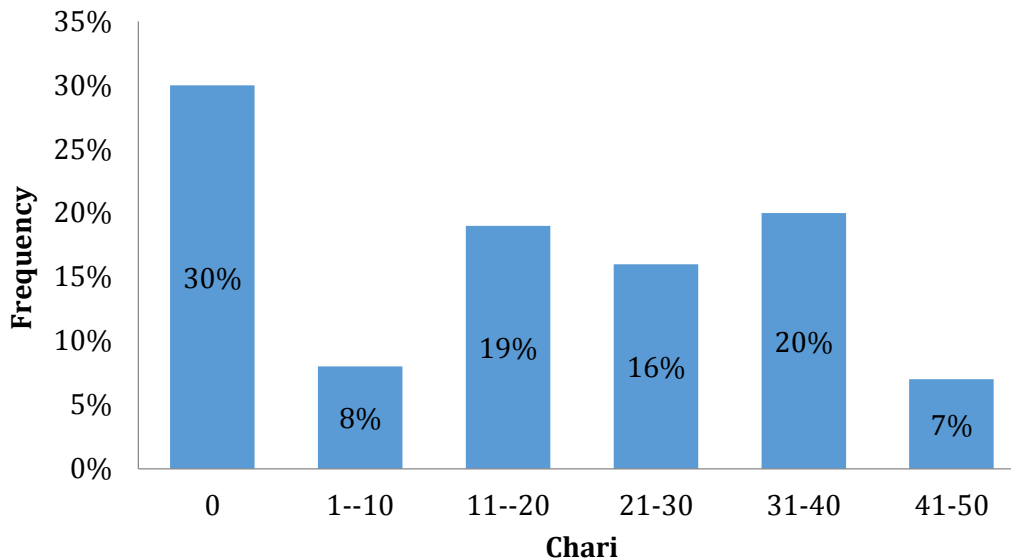


Figure 9. Number of composting bin/chari in the study area

Monthly income of people in the SA through VC process

It was observed that the monthly income of about 10% of the respondents is about less than 5000 Tk. The monthly income of about 12% of the respondents is about 5000-10000 Tk. The monthly income of about 38% of the respondents is about 11000-15000 Tk and the rest 10% of the respondents monthly income is about 16000-20000 Tk. It is indicated that the socioeconomic conditions in the study area are mostly dependent on vermicomposting technology (Figure 10).

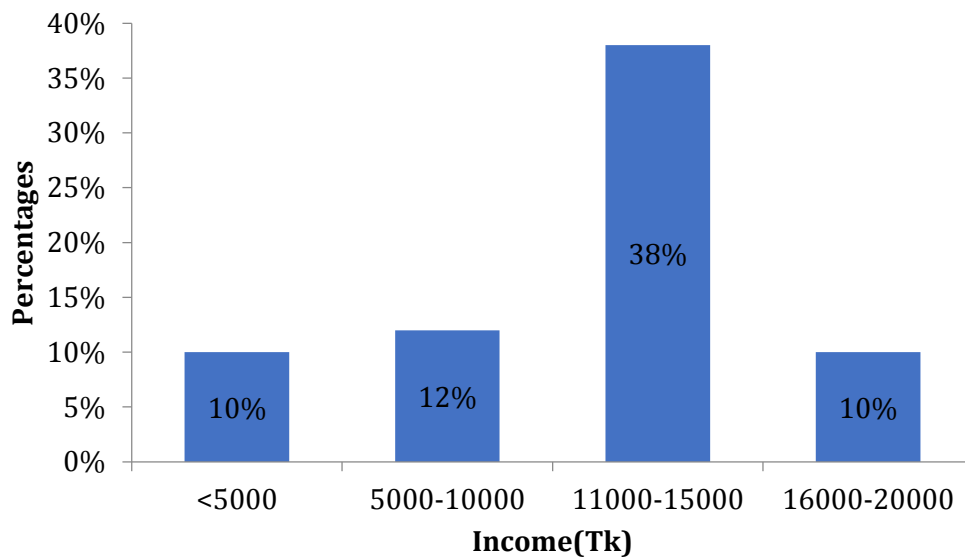


Figure 10. Monthly income of the respondent

Sanitary conditions of the respondents of the study area

From the study area, 87% of the respondents were not under the sanitary conditions in the past. But at present only 2% of the respondents are without sanitary conditions. They also expressed that about 20% of latrine of the respondents are kacha but in the past it was only 7%. At present about 57% of latrine is semi-pakka but it was only 4% in the past. On the other hands about 23% of the respondent's latrines are pakka at present but it was 2% in the past. Vermicomposting technology has changed their sanitary conditions through earning capacity of money (Figure 11). Vermicompost is considered as an excellent product since it is homogenous, has desirable aesthetics, has reduced level of contaminates, has plant growth hormones, higher level of soil enzymes, greater microbial population and tends to

hold more nutrients over a longer period without adversely impacting the environment (Thentu et al., 2015).

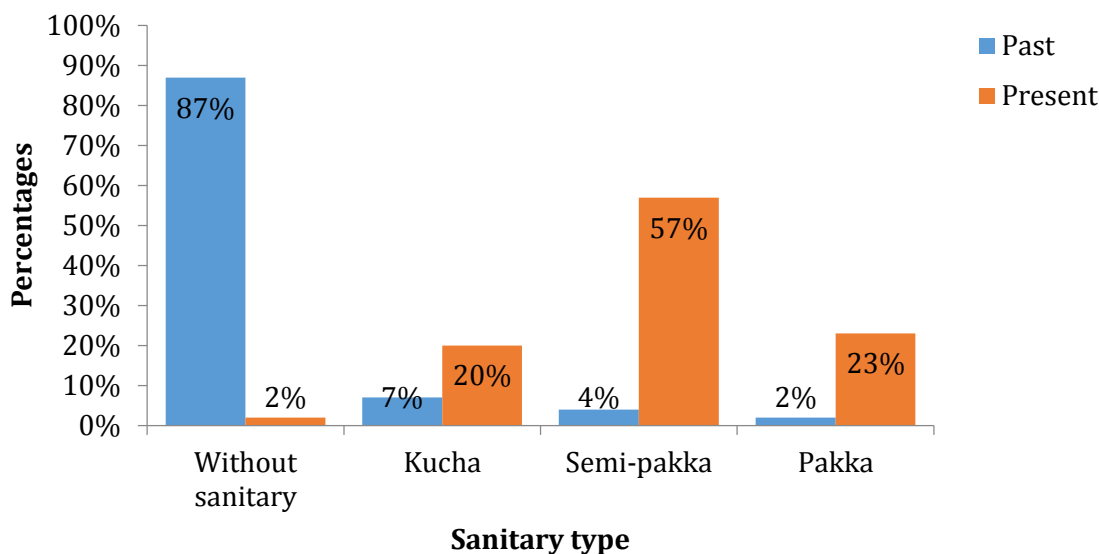


Figure 11. Sanitary condition of the study area

Various crop yields with VC and chemical fertilizers

According to the information of the local people of the study area the percentages of the crop yields were very low in the past but now a days the production of crop yields are increasing day by day due to vermicompost. In the past various crop yields were very high with the help of chemical fertilizers but at present the crop yields production rate has been decreased due to chemical fertilizers. On the other hands the crop yields were less produced with vermicompost but the crop yields are increasing day by day with the help of vermicompost (Table 4). Scientists reported (Edwards and Steele, 1997) that in a Rothamsted (UK) study with 25 types of vegetables, fruits or ornamentals, earthworm casts (EW) performed better than compost or commercial potting mixture amendments. It increases in paddy production by 10-20%, wheat 15-25%, Maize 28-35% and vegetable by 20-35% (Khan et al., 2012).

Table 4. Crops yield with vermicompost and chemical fertilizer

Crops	Using chemical fertilizer		Using vermicompost	
	Past (%)	Present (%)	Past (%)	Present (%)
Rice	80	65	40	80
Jute	70	32	23	68
Betel leaf	85	9	73	92
Sugercane	90	70	70	95

Various reasons for choosing vermicompost system

The local people of the study area are so much interested to apply vermicompost to their agricultural lands and homesteads lands. Various causes are related with the choice of vermicompost in lieu of chemical fertilizers. The main causes are the low price of vermicompost, it can be manually produced. It has increased the crop yields and the income of the local people (Figure 12). A growing awareness of some of the adverse economic and environmental impacts of agrochemicals in crop production has stimulated greater interest in the utilization of organic amendments such as compost or vermicompost for crop production (Follet et al., 1981).

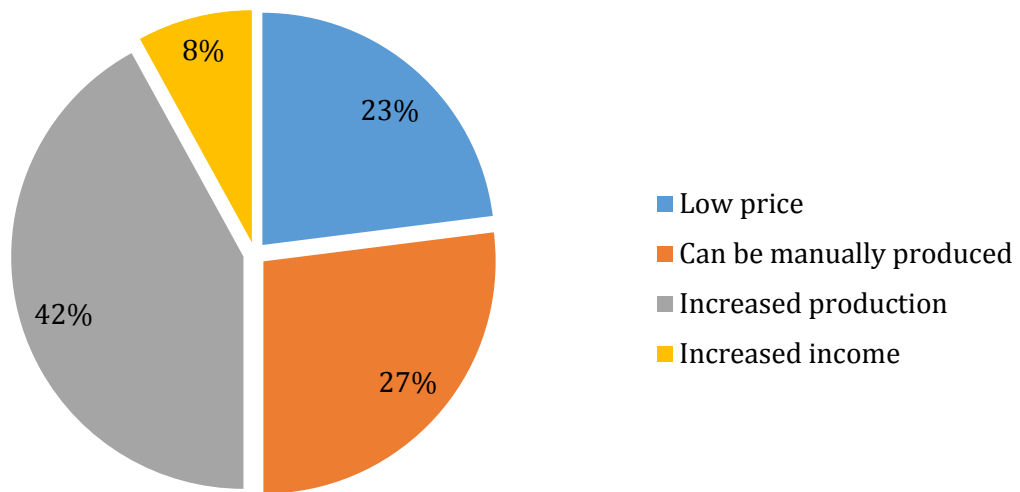


Figure 12. Various reasons for choosing vermicompost

Adoption of vermicomposting technology to the local people of the study area

The socioeconomic and agricultural condition of the study area has been improved due to vermicomposting technology. The local people have adopted vermicomposting technology due to various causes. The vermicomposting technology has increased crop yield 22%, has increased soil fertility 27% and decreased crop production cost 12%. It decreased the dependent on chemical fertilizer 8% and enhances the effectiveness of fertilizer 6%. Minimize the waste volume 19% and for health and food safety 6% (Figure 13). The beneficial effect of earthworms on plant growth may be due to several reasons apart from the presence of macro nutrients and micronutrients in vermicasts and in their secretions in considerable quantities. It is believed that earthworm produce certain metabolites, vitamins and similar substances into the soil which may be the B or D group vitamins (Nielson, 1965).

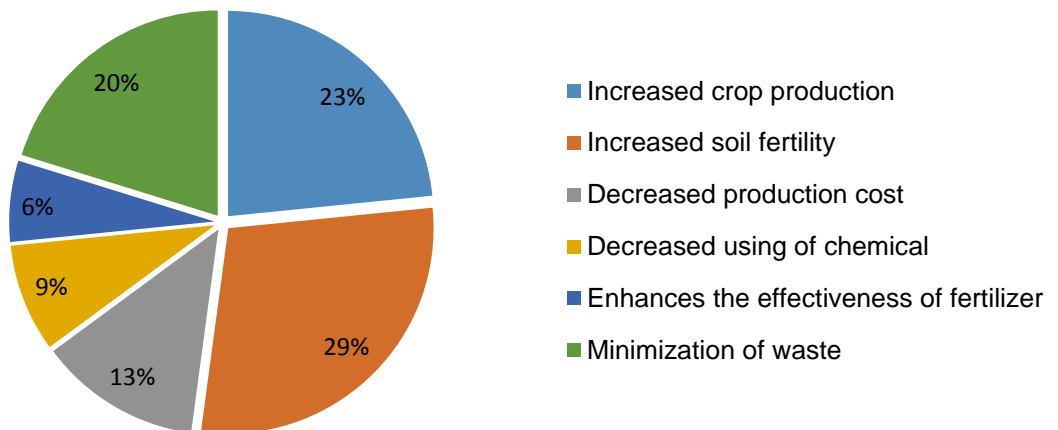


Figure 13. Causes for adoption of vermicomposting technology

Constraints to adopt vermicomposting technology in the study area

It has observed that most of the respondents of the study area are poor. They have lack of knowledge, lack of awareness and lack of capital. Various authorities and organizations do not help them as their demand. The most indicated problem is the sale related problem (Figure 14).

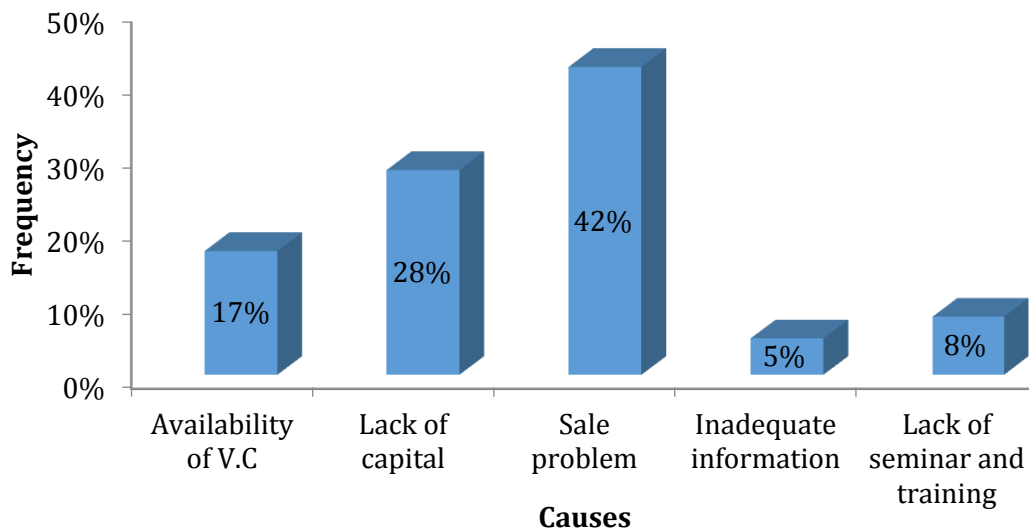


Figure 14. Constraints to adopt vermicomposting technology

IV. Conclusion

Vermicomposting process could be converted the organic waste into half amount of organic fertilizer that is known as vermicompost. Earthworms serve as nature's plowman and form nature's gift to produce good humus, which is the most precious material to fulfill the nutritional needs of crops. The vermicompost use intensity in the study area was high due to the hazardous impact and high price of chemical fertilizer whereas the vermicompost was really low in price and free from all hazardous impact. Vermicompost can be used for all kinds of crops. About 90% of the respondents in this area use vermicompost with low amounts of chemical fertilizer and they are satisfied of their productions. There is need low amounts of chemical fertilizers when they use vermicompost in their lands. Before vermicomposting unmanaged waste caused serious environmental problems and they suffer from various disease but their environment conditions is better now. Women in this area are selves dependent because they earn money in staying at home by using vermicomposting technology. In this feel, vermicomposting is compatible with sound environmental concepts that value sound conservation of resources and sustainable practices.

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APA (American Psychological Association)

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