

Food Waste Management in Bangladesh

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Food waste management is a critical environmental issue in many developing countries, including Bangladesh, due to unplanned food waste disposal and lack of dedicated food waste legislation. In those countries, a significant amount of food waste is discarded to the environment rather than being recycled. In Bangladesh, food waste is traditionally often used for composting, landfilling, and feeding animals, as there is no valorization option. In addition, food waste and food waste streams of food industries are utilized for the recycling and production of diverse economically valuable bioactive compounds.

food waste

waste valorization

circular economy

1. Introduction

Food waste (FW) management is regarded as a critical environmental issue in developing Asian countries due to a lack of scientific knowledge and specific legislation for protracted management ^{[1][2]}. Owing to favorable climatic conditions, Bangladesh is one of the main vegetable- and fruit-producing countries in South Asia ^{[3][4]}. However, a large volume of these perishable goods was reported to be destroyed because of the inadequate availability of efficient packaging, processing, and conversion technologies ^{[3][4]}. As a result, unintended food losses during production and postharvest processing are a serious concern in the country. Furthermore, management of this huge agricultural waste is a big burden for this nation, both in terms of the environment and the economy ^{[5][6]}.

FW and FW streams are treated as an excellent array of hidden bioactive molecules and bioenergy ^[1]. Globally, FW streams are converted into bioenergy and utilized for the production of valuable products through integrated biorefinery ^[7]. This integrated food waste valorization approaches toward the circular economy are now being in practice in most developed countries as waste management solution ^{[8][9]}. The FW streams have already been reported as useful input to a circular economy ^[10], not only as a source of bioenergy, but also as a source of recycled products. In emerging Asian markets, the circular economy through FW valorization may play an essential role, which has yet to be extensively investigated ^{[1][11]}. The worldwide FW dilemma and its long-term management through integrated and novel biorefinery and repurposing technologies have been discussed in many reports ^{[12][13]}. However, scant information is available on the potential of sustainable recycling of FW for the production of valuable products in developing Asian countries, including Bangladesh.

Several reviews of the literature reveal that the majority of the waste management research and policy legislation in Bangladesh focuses mainly solid waste (MSW) ^[14]. In addition, the environmental impact of existing waste management strategies was also reviewed in some studies ^[15]. However, the urban and municipal waste management seemed to be the focus area for research regarding Bangladesh, leaving behind the whole country scenario ^{[16][17]}. A large number of reports have been published on policy and the sustainable MSW management of major cities, with some valorization options ^{[18][19]}. Following the trend, some MSW involved technology to use the solid waste potentiality in terms of energy and bioproduct as well ^{[20][21]}. In addition, for clean city development in Bangladesh, certain waste-to-energy (WtE) technologies for biogas, biohydrogen, and other resource recovery have been investigated ^{[22][23][24]}. Surprisingly, FW and its management were not independently explored in Bangladesh ^{[2][4]}; except for a few studies which were focused on restaurant food waste and marine waste management ^{[6][25]}. It is possible that the FW valorization and the prospects of bioconversion of value-added products

from the FW and FW streams in Bangladesh is poorly understood. Therefore, a comprehensive review of FW management and the potential of utilizing FW materials for the circular economy through sustainable recycling is needed.

2. FW Status in Bangladesh

FW has become a big concern in Bangladesh due to the country's rapidly growing population and changing food habits. According to a previous study, total household food waste in Bangladesh is approximately 10.62 million tons each year, which could be a great problem if the FW was not managed properly [26]. The fraction of FW in aggregated MSW of Bangladesh ranges from 68.3% to 81.1% [5]. In Bangladesh, FW generation is primarily linked to restaurants, agricultural operations, kitchen trash, and related residential activities and social parties. Thousands to millions of tons of food are wasted every year as a result of these anthropogenic activities that are not addressed by any comprehensive regulation. Harvest losses of 7.82 and 7.58 million tons, distribution losses of 2.36 and 2.13 million tons, and consumer waste of 3.78 million tons are all included in this FW rate [27]. The situation is different in the case of restaurant-based FW, where consumers are accountable for 56% of the waste following meal preparation and cooking [6]. The food production and consumption cycle generated around 23.69 million tons of FW in the years 2016 and 2017 [28].

In general, Dhaka produces the least MSW (68.3 wt% of FW) among eight districts, while Barisal federates produce the most, accounting for 81.1 wt. percent of FW in the country's total MSW [23]. The quantities of FW produced in various regions of Bangladesh including rural and urban areas are shown in **Figure 1**. Dhaka alone disposes of approximately 1,241,133.23 tons of FW every year [5]. According to official estimates, the food wastage rate in the industrial city of Chittagong is 421,330.45 tons each year [2]. Although the food wastage rate increases or decreases depending on the season, these values incorporate the FW rates in both the dry and wet seasons in tropical countries [29].

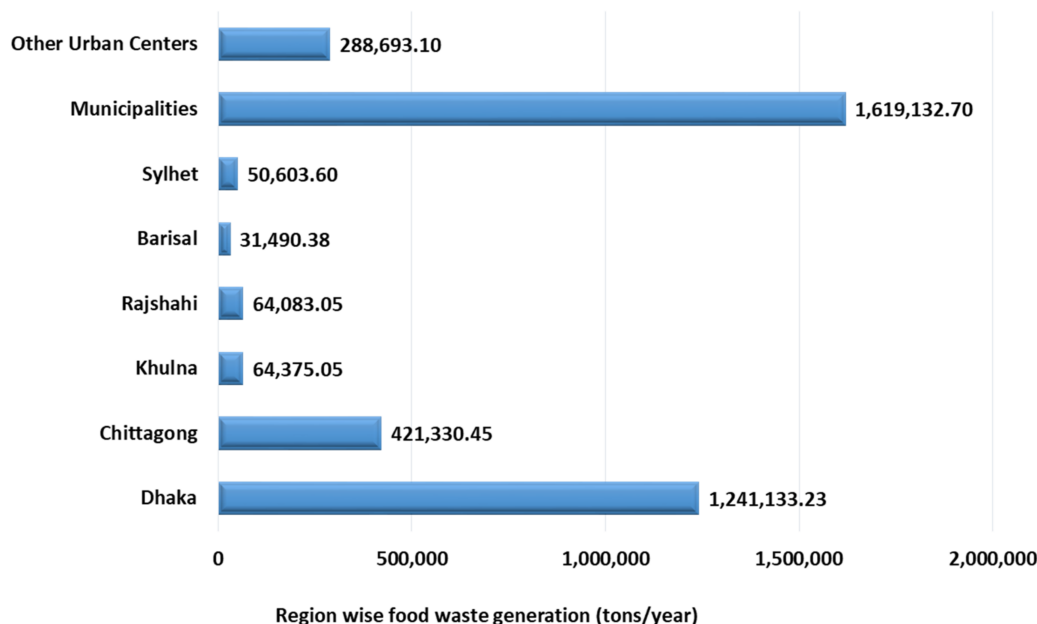


Figure 1. FW generation data of the different regions of Bangladesh. Data were adapted from earlier studies and references dealing with FW generation [2][5][16][17].

3. Management of FW in Bangladesh

In general, no specific FW management policy is followed in Bangladesh. FW is usually managed as a component of MSW [2]. However, there are some basic and traditional management strategies for FW disposal and further utilization in Bangladesh. The general mechanism is storing the FW from different sectors through waste collectors and making the best use of it to ensure compliance with the general waste management policy. However, the appropriate knowledge of the two types of FW and their common management in Bangladesh is not well established. In the case of restaurant-based FW, waste is first stored in a small room with fan ventilation (for 80% of large restaurants and 69% of small restaurants) [4] and is then collected by collectors for disposal. Another important aspect is that some of this FW is composted, which is highly beneficial. Household FW is also used for composting and as animal feed, and this does not require any storage processing.

4. Existing Strategies of FW Management in Bangladesh

Three general waste management strategies are currently used in the urban community of Bangladesh [2][4], namely, (1) a formal system, where the city government is responsible for waste management; (2) a community initiative, where voluntary actions are required for waste management; and (3) an informal system, where a large number of informal workers are responsible for organic waste management (**Figure 2**) [2][23]. After taking action through one of the three organizations, a few steps should be followed. Waste bins are used in homes, restaurants, and other establishments for this purpose [4][6]. The FW from households is gathered by waste collectors. This is usually done by the government or by individuals without any specific legislation. The FW is then disposed of or minimized through the three most common procedures, which include landfilling, open burning, and sometimes open dumping. Recycling of FW is very limited. It is accomplished through three traditional methods, namely, aerobic digestion, animal feeding, and composting [30]. These solutions can be applied to any sort of FW that occurs in our environment, but the disadvantage is that they require a processing area. Food waste refers to unavoidable food waste, but avoidable food waste is the only option to prevent FW generation [31][32]. There is a clear lack of adoption of innovative and sustainable FW management systems in Bangladesh, whereas global research has already expedited several cutting-edge policies and valorization approaches to managing and recycling global FW [12][33]. Therefore, Bangladesh needs policy formulations and research for the utilization of the vast amount of FW as a bioresource for the production of economically useful products.

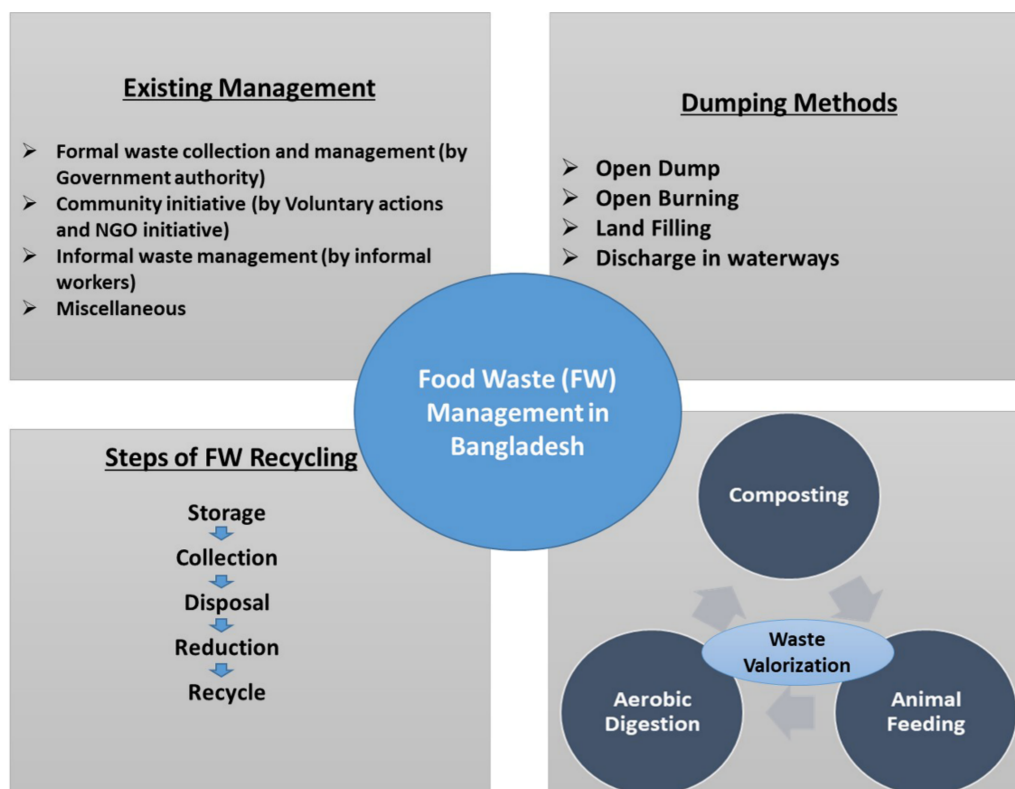


Figure 2. Existing strategies for FW management in Bangladesh.

5. Misconception and Negligence about Good Policy for FW Recycling in Bangladesh

In general, waste is created through a complex interaction of multiple stakeholders, including producers, distributors, consumers, food industries, food chain entry points, waste collection authorities, nongovernment organizations, and government agencies involved in FW management, and local governments alone are unable to manage the growing volume of municipal and FW [17]. Except for a few restaurant-based FW studies, the sustainable and good policy of FW recycling in Bangladesh has received little attention [4][22]. However, in developing Asian countries such as Bangladesh, several misconceptions, poor legislation, ignorance of food policy, lack of government and stakeholder initiatives, lack of funding, inappropriate technologies, and insufficiently skilled staff resources on FW management issues have all hampered the planning and application of novel approaches to achieve a wise FW management system [22].

Proper community education is a crucial influencing factor on consumer behavior, which impacts FW generation and control [34][35]. According to the World Bank, developed countries spend over 90% of their budgets on waste management programs, treatment facilities, or specific initiatives to raise public awareness about the effects of garbage on the environment. On the other hand, developing countries spend about 80% of their budgets on garbage collection and disposal [34]. People may play a critical role in sustainable FW management if education, awareness, and government enforcement are coordinated [2]. Last year, the total budget deficit was BDT 214,681 crore, or 35.5% of the total budget. This funding gap suggests that the government is having difficulty making significant investments in FW management [27]. Although it will be challenging, Bangladeshi authorities may seek international money and public–private partnerships to assist them in achieving long-term FW management.

In developing countries, traditional technologies such as anaerobic digestion (composting), open dumping with MSW, animal feeding, and landfilling have been used to handle food waste [31]. Contemporary recycling technologies such as valorization strategies (i.e., WtE approach, extraction of bioactive compounds, and integrated biorefinery) are not included in emerging regions such as Bangladesh due to a lack of technical capabilities [3][20]. In Bangladesh, municipal waste management authorities do not have a specific strategy for collecting and processing FW, which is intermingled with MSW management and not segregated for separate trash management [2]. However, certain nongovernment groups (e.g., Swisscontact BD) have sustainably undertaken a few efforts to handle municipal garbage and related FW with the help of international organizations [15][19].

The lack of utilization of novel and appropriate technology for the specific goal of FW extraction has been identified as a significant obstacle to FW management efficiency in developing countries [32][34]. Due to the absence of understanding of sustainable technologies, FW at entry points during the manufacturing to retailer stages is substantially higher in developing Asian countries than in developed countries [1][28]. Therefore, implementing sustainable and innovative FW recycling using advanced and technical approaches is vital and still needs to be explored in Bangladesh.

According to a recent study, FW reduction in many countries is hampered by surplus food for guests, friends, and family due to hospitality [4]. Bangladesh is undoubtedly considered a hospitable country. The offering of abundant meals for visitors is frequently viewed as a symbol of social standing. Thus, food is regularly discarded in large quantities, especially at family reunions and other festivities. The government should approach a comprehensive FW management strategy for Bangladesh as soon as possible to avert the looming food crisis. A master plan for FW reduction and management should include new regulations to limit FW generation and infrastructure to support long-term FW management. Comprehensive and significant training, socialization, and communication effort among all stakeholders will drastically reduce FW.

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