Institutional Solid Waste Management Practices: Case study of Agriculture University in Kashmir

Abstract

This paper reports on institutional solid waste management in Sher-Kashmir University of Agricultural Science and Technology Kashmir. It is noted that there are indeed advantages in managing solid waste at institutional level because of the institutions' unique characteristics that also influence their waste management needs. The paper outlines findings from a yearlong study on institutional solid waste management. Surveys and field investigations, including on-site waste measurements and questionnaire surveys were done at the University. The composition of the waste was found to be predominantly organic in nature, suggesting a strong resource recovery potential in terms of organic waste or production of biogas through anaerobic digestion and compost. The study has shown that resource recovery could greatly enhance solid waste management at the other case study institutions.

Introduction

1.1. Background

Rising incomes, rapidly growing but unplanned urbanisation, and changing lifestyles have resulted in increased volumes and changing composition (increasing use of paper, plastic and other inorganic materials) of municipal solid waste in India. The volume of waste is projected to increase from 64-72 million tonnes at present to 125 million tonnes by 2031. Untreated waste (a mixture of biodegradable or wet waste and non-biodegradable waste) from Indian cities lies for months and years at dumpsites where land was originally allocated for developing landfills for safe disposal of only the residual waste.

The decomposition of organic matter in the airless heaps of waste at these dumpsites contributes to global warming by Green House Gas emissions. Since the present generation of waste is also not handled effectively, it exacerbates the problem. Ideally, the infrastructure and delivery mechanisms for solid waste management, drainage, sewerage, and waste water treatment should be planned and implemented in a co-ordinated framework of a city development plan. Besides paying attention to ameliorate the immediate environmental and public health crises resulting from the current very poor state of solid waste management, there is need for a clearly articulated medium term strategy to address the challenges of solid waste management in Indian cities.

Solid waste refers to any discarded material that is abandoned by being disposed of, burned or incinerated, recycled or considered "waste-like." A solid waste can physically be a solid, liquid, semi-solid, or container of gaseous material. Solid waste includes garbage, construction debris, commercial refuse, sludge from water supply or waste treatment plants, or air pollution control facilities, and other discarded materials. Solid waste can come from

industrial, commercial, mining, or agricultural operations, and from household and community activities. Solid waste does not include wastes such as solid or dissolved materials in domestic sewage, or source, special nuclear, or by-product material. The management of solid waste can include source reduction, recycling, storage, collection, transportation, processing, and disposal. Examples of solid waste facilities include landfills, composting sites, transfer stations, incinerators, and processing facilities. Such facilities may be publicly or privately owned.

Solid waste is the unwanted solid materials generated from human activities in residential, industrial or commercial areas. Solid waste does not have any economic value from the point of view of first owner. It may be categorised in three ways. According to its: origin (domestic, industrial, commercial, construction or institutional), contents (organic material, glass, metal, plastic paper etc), hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc).

Solid Waste Management reduces or eliminates the adverse impact on the environment & human health. A number of processes are involved in effectively managing waste for a municipality. These include monitoring, collection, transport, processing, recycling and disposal. The quantum of waste generated varies mainly due to different lifestyles, which is directly proportional to socio economic status of the urban population.

Solid waste management in developing countries is plagued by a number of problems, solutions for which are mainly constrained by financial and technological deficiencies. The most problematic functional element of solid waste management in developing countries, especially India, has been identified as disposal (Kasseva and Mbuligwe, 1999). A manifestation of this problem is pollution of ground and surface water sources by leachate from poorly managed and illegal solid waste dumps. Minimizing waste generation by focusing on management practices at the source can save disposal sites space, reduce illegal dumping, and therefore, cut down on pollution potential from solid waste. A focus on sources of waste in respect of management is justified by the fact that waste characteristics and composition differ according to source (Tchobanoglous et al., 1993). It is also justified by the fact that it is indeed easier to manage discreet waste types than mixed ones. This is because in the latter case additional time, effort and cost have to be incurred in order to segregate the waste for resource recovery or simply for easy handling. The current mismanagement with respect to solid waste management is to handle the waste wholesale. This can partly be attributed to the fact that waste management authorities do not address individual sources of the waste, which are many, hence, difficult to deal with individually. The exceptions to this rule are institutions like colleges, industries and large commercial premises like large hotels. These generate large enough amounts of waste to justify individual attention. It is considered advantageous to look at solid waste management at institutional level partly because of large sizes of the institutions, and mostly because the institutions currently manage their waste themselves to a great extent. Also, due to the integrated nature of their activities, institutions can easily fashion out their own mini-solid waste management systems within the large municipal solid waste management system framework. With such systems in place in institutions, resource recovery and waste recycling can more easily and effectively be incorporated, reducing the pressure on solid waste disposal sites.

This paper presents findings on institutional solid waste management in Sher- Kashmir University of Agricultural Sciences and Technology Kashmir SKUAST(K). It points out aspects that can be addressed to improve institutional solid waste management and contribute to the improvement of municipal solid waste management in general. It advances the notion that municipal solid waste management can be improved through efforts focused on individual sources with emphasis on waste minimization rather than provision for disposal.

1.2. Background to the case study institutions

Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir is an agricultural university located in Shalimar, Srinagar, Jammu and Kashmir, India.[1] With its main campus and Faculty of Horticulture in Shalimar, Srinagar, the university has multiple campuses, colleges, research and extension centers across the Kashmir Valley. In 1979, the expert team of Indian Council of Agricultural Research (ICAR) on the proposal of state government recommended the establishment of an agricultural university for the advancement of the agricultural sector in the state. The Act for the establishment of a university under the name and style of Sher-e-Kashmir University of Agricultural Sciences and Technology was passed by the State Legislature in the 33rd year of the Republic of India on 31 March 1982 which came into force on 1 August 1982 with its jurisdiction over the entire State of Jammu and Kashmir and headquarters at Shalimar, Srinagar. Today the university operates on the Land-Grant College concept following the Model Act of SAUs evolved by ICAR. It is a multi-campus university.

1.3 Waste management

Human interactions with the environment (human activities) have always resulted in waste production. However, Giusti (2009) reported that waste production and management was not a major issue until people began living and managing it together in communities. Vergara & Tchobanoglous (2012) reported that as population and purchasing power of people increases worldwide, more goods are produced to meet increasing demand, thereby leading to the production of more waste. Marchettini *et al*. (2007) pointed out that, these continuous flows of waste resulting from human activities, overburdened the environment. Vergara & Tchobanoglous (2012) reported that proper planning and control is required in other to prevent the negative impact of waste on the environment. As a result, Ghiani *et al*. (2014) added that, a proper organization of solid waste management has become an essential task needed to safeguard the environment. Beranek (1992) argues that the provision of an efficient solid waste management system is now as important as other essential amenities such as electricity, airports, and highways. Basu (2009) pointed out that due to the increasing volume of waste. The continuous disposal of waste to landfill is unsustainable. Hence, Basu argues that the processing of waste is a necessary step needed to safeguard public health. Demirbas

(2011) describes waste management as a process by which wastes are gathered, transported and processed before disposal of any remaining residues. Similarly, Tchobanoglous *et al.* (1993) describe solid waste management as the effective supervision and handling, keeping, collection, conveying, treatment and disposal of waste in a manner that safeguard the environment and the public. Tchobanoglous *et al* (1993) added that, solid waste management utilizes skills and knowledge from various discipline such as legal, financial, administration among others in the day to day running of waste management issues. Demirbas (2011) suggested that the main reason for managing waste is to ensure a safe environment.

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials. Waste management is undertaken to reduce their effect on human health and environment. Waste management is a distinct practice. All waste materials, whether they are solid, liquid, gaseous or radioactive fall within the domain of waste management. It was observed in the campus, there is no proper waste management system. These materials are dumped together in the open space. Plastic materials are being burnt in the open space without using proper incineration techniques, which may cause various health and ecological problems and heaps of solid waste at different places around and within the campus leads to foul smell that causes various health issues.

2. Materials and methods

2.1. Materials

Survey was conducted from January to December during the year 2021. The materials used for the measurement of wastes were a weighing balance of capacity, and in plastic bins for collecting and weighing the waste. Other facilities were shovels and forks for loading and sorting the waste; and gloves, gum boots and facemasks for personal protection. The targeted types of solid waste were: Food waste, Plastic waste, Paper waste and Metal waste.

2.2. Methods

2.2.1. Measurement sites

Measurements of wastes were carried out at student hostels, messes, residential quarters, canteen, fields, guest houses, faculty offices and health centre. The selected measurement places were the ones that were deemed to represent major and typical sources of waste. This was in line with the need to get a representative spectrum of sources and types of wastes from the institutions.

2.2.1.1. Student hostels: Four hostels of students at SKUAST (K) Shalimar Campus, were selected, representing 32% of all students' accommodation capacity. The two halls also catered for characteristics of waste from both female and male students.

2.2.1.2. Staff residential solid waste sources. Waste sample taking at 18 residential quarters.

2.2.1.3. Health facilities: The health centre and dispensaries cater for students, staff families and outsiders.

2.2.1.4. Cafeterias. Cafeterias had been commercialized and privatized. Workers while academic staff members normally take their meals at a canteen

2.2.1. Other measurement places. Other sampling and measurement places for solid waste included offices

2.2.2. Questionnaire surveys and interviews: Data and information on solid waste management practices at the three institutions were additionally obtained from their respective estates department officials, waste collection crew, halls' attendants, households and other relevant people through questionnaire surveys and interviews. Selection and sizing of household samples was the same as for waste measurement. The estates department officials interviewed were those concerned with solid waste management at the respective institutions. Personnel consulted in respect of other sources of waste were also those responsible or conversant with solid waste management at the respective sources.

2.2.3. Visual inspection and field investigations

Visual assessment and field investigations in the institution was done to assess the aesthetic quality of the study area and to establish a basis for evaluating how study facts and figures correlate with visual evidence on the ground. The assessment and investigations were also done to aid selection of sampling and measurement points to combine visual judgement with theoretical findings based on available data. Additionally, the assessment and field investigations were done to get first-hand experience of how solid waste is actually managed at the institution under normal working conditions.

2.2.4. On-site waste segregation and measurement

The procedures followed in the measurement of solid waste samples were as follows:

- Determination of weight (Wb) of empty bin using the weighing balance;
- Filling of the bin with sample waste while shaking the bin constantly to avoid undue void spaces;
- Determination of gross weight (WT) of (bin) container and waste using the weighing balance
- Determination of the interval (ts) during which the waste was stored and the number of people (p) who contributed to the waste generation.

The above procedure was followed for the measurement of samples of wastes on different sampling days and at different waste sources during the whole study period.

The waste generation rates (WG) were computed using the relation:

$$W_G = = \frac{(WT-Wb)(kg)}{p(pe)\times ts(d)} (kg.pe^{-1}d^{-1})$$

Where pe is population equivalent.

2.2.5. Statistical analysis

The data obtained in respect of various observations were analyzed statistically. The significance of 'F' and 't' was tested at 5 per cent level of significance. The critical difference value was calculated when 'F' test was significant. SPSS software was used for statistical analysis.

3. RESULTS AND DISCUSSION:

3.1. Solid waste management practices

3.1.1. Current solid waste management practices

Types of wastes and sources of waste from the institution is shown in **Table 1.** On-site primary storage of waste is by way of bins, which are hauled manually to centralized enclosures or disposal site for residential quarters and offices.

Table 1: Sources and types of wastes from different institutional sources

S.No	Source	Type of waste
1	Hostels	Paper, food leftovers, food preparation waste, clothes, plastics and sanitary waste
2	Canteen	Bones, food leftovers, food preparation waste, ash, tins, bottles, wrappers and paper
3	Residential quarters	Food leftovers, food preparation waste, papers, ash, vegetables, clothes and plastics
4	Offices	Mainly paper and plastic
5	Health centre	Disposable syringes, cotton wool, bottles, plastics, food leftovers, food preparation waste, paper, bandages and waste paper
6	Fields	Twigs, leaves and ashes
7	Laboratories	Paper, plastics, discarded samples and chemicals

8	Guest houses	Food waste, plastics, sanitary waste and others

3.1.2. Segregation of waste:

Wastes collected from different sites of the campus were segregated into four major types viz: food waste/degradable waste, plastic waste, paper waste and metal waste.

Table:2: Description of the solid waste from various sources:

Source	Description of wastes (Kg)			
	Organic waste	Plastic waste	Paper waste	Metal waste
Hostels	**45452.81**	**17779.00**	**21636.75**	**0.18**
Messes	**53327.58**	**277.7**	**1215.38**	**1.22**
Laboratories	**843.56**	**168.32**	**108.15**	**0.04**
Offices	**9062.7**	**4276.03**	**4018.34**	**0.02**
Residential quarters	**4385.22**	**1872.8**	**2220.3**	**0.36**
Health centre	**80.73**	**68.78**	**99.55**	**0.01**
Canteen	**3881.51**	**247.98**	**259.35**	**0.29**
Guest houses	**249.15**	**296.77**	**237.9**	**0.16**
Fields	**69.99**	**31.65**	**1.711**	**0.02**

3.1.2.1. Organic waste:

Sources of organic waste in the form of food leftovers, food preparation waste, vegetable and fruit refuse and farm refuse are hostels, residential quarters, canteen, fields, farmer's hostel, guest houses, faculty offices, and fields etc. Total organic waste generated was 113633.24 Kg during the year 2021 with maximum quantities collected in the months of July to October (12127.9, 11505.7, 11332.4 and 11496.9 Kg), because of higher presence of students in those particular months. Maximum contribution to food waste was from messes of the hostels. From the graphs plotted indicates that organic waste that is biodegradable contribute most to the solid wastes in campus and its proper disposal could make a significant change in the waste management system.

3.1.2.2. Plastic waste: Total plastic waste generated was 25 tonnes, maximum contribution to plastic waste was from residential quarters with 20-30 families living in the quarters**,** in addition to that student hostels also serving as a major source of origin of the waste in the university. The data collected showed higher amount of waste generated in the months of July and August (2893.02 and 2960.35 Kg) respectively during the year 2021. This may be attributed to higher use of fluids by the inhabitants in these summer months contributing to higher rates of plastic generation.

3.1.2.3. Paper waste:

Total paper waste generated was 29 tonnes, maximum contribution to paper waste was from hostels with 200-300 students residing in this university each year.

3.1.2.4. Metal waste:

Hostel messes being the main source of metal waste because of over use of canned food packed in metal tins in the hostels in these particular months of winter.

Therefore the annual average solid waste generated in the University campus is 1136.32 Qtls. Out of which the total quantity of food waste generated is 521.82 Qtls, total plastic waste is 249.87 Qtls, total paper waste is 294.48 Qtls, total metal waste is 0.02 Qtls and farm waste is 70.11 Qtls.

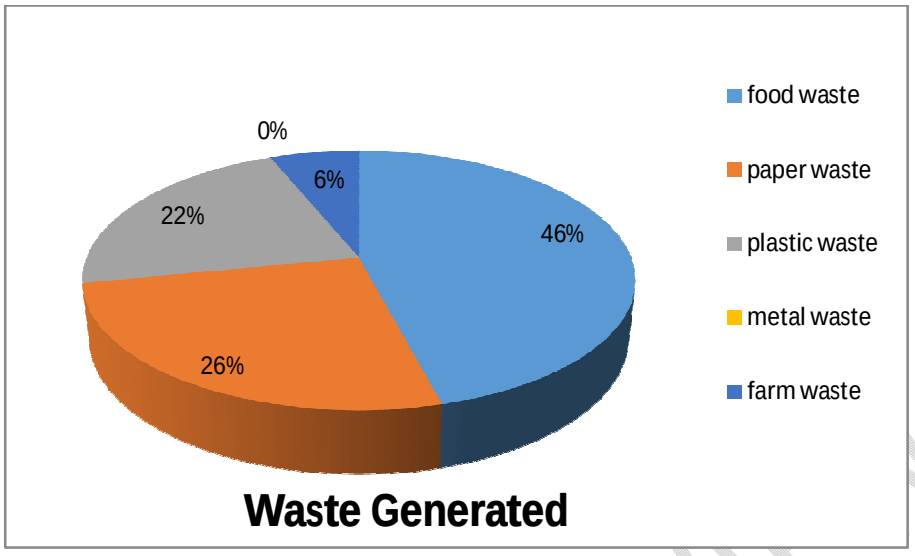


Fig.1 Total Waste generated

Total waste generated from the institution was 111.482 tonnes. Out of this, 57.010 tonnes was food waste, 29.450 tonnes was paper waste, 25.019 tonnes was plastic waste and 0.0025 tonnes was metal waste. The major sources of institutional wastes are hostels, residential quarters, fields and canteen. The waste from these sources constitutes mainly organic waste constituents, including food leftovers. This suggests a potential for recovery of organic constituents of the waste, especially food leftovers and food preparation waste as animal feed. The remainder of the organic waste can be composted or processed for energy recovery through decomposition. In this regard surveys were conducted in hostels, offices, laboratories, hostel messes, canteen, fields, health centre, classrooms, parks and residential quarters of SKUAST –K Shalimar Campus. Awareness programs were carried out within the campus and colour coded bags were distributed among hostel students, residential quarters, laboratories, offices, canteen etc. Main focus in the awareness program was to segregate the waste so that there will be effective solid waste management.

Fig.2: Awareness program at Shalimar campus

Fig.3: Distribution of colour coded dustbins and bags

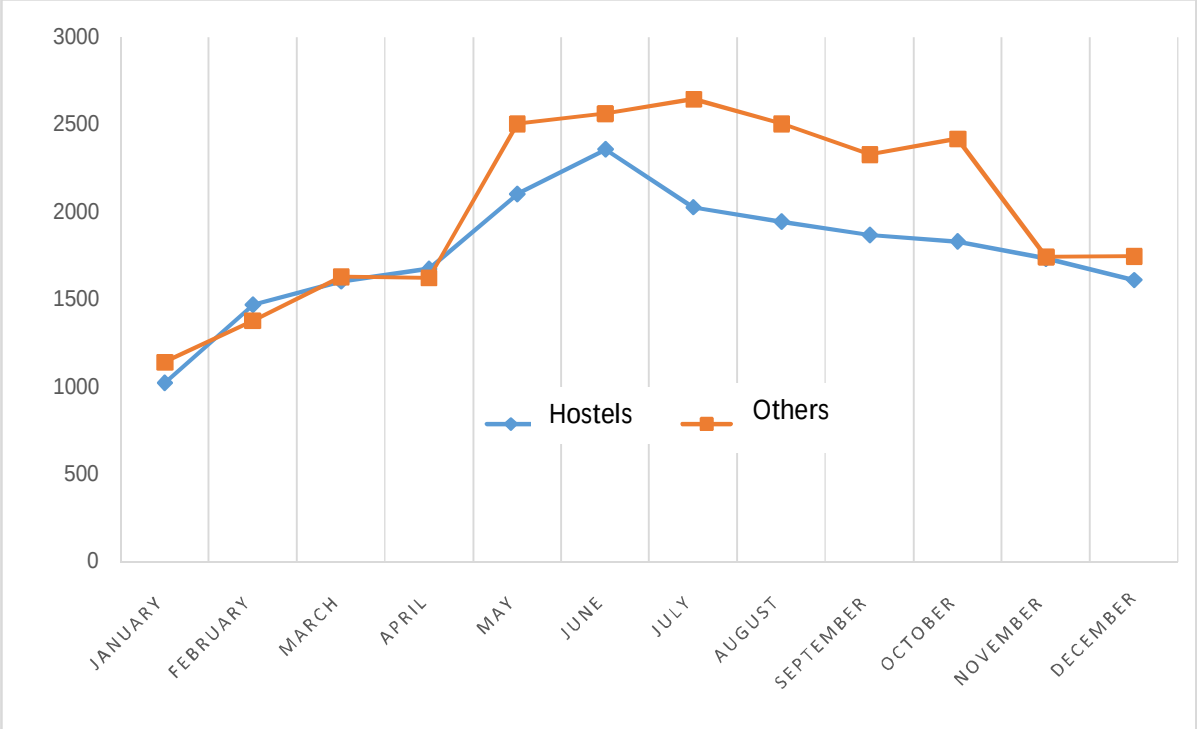
Fig 4 : Weighing of food wastes

3.1.3. Resource recovery and recycling of waste

Food waste from hostels and canteen, is reused as animal feed (for dogs) by lecturers and other staff of the institutions as well as non-staff individuals. Plastic bags and papers were also collected for reuse but to a smaller extent and by low cadre scavengers. Aluminum food and drink cans can be collected for sale. Wastepaper can be sold to various people for recycling within and outside the institution. For the resource recovery suggested above to work, it is obvious that source separation of waste is important. This is because mixed wastes are not suitable to recycle due to their need for post-generation segregation, which is inconvenient and usually not effective.

It is prudent to point out that, the above resource recovery potential is not easy to achieve because it is influenced by many factors. For example, prior to composting, the moisture content of the organic waste component will need to be adjusted. This can be achieved through mixing the waste with other relatively dry wastes or by drying the waste directly. In addition, the waste has to be segregated, preferably at the source. For segregation of waste at the source to work well, there is a need for sensitization of the concerned communities.

Fig:5: Waste generated (kg) from Hostels and other site in the Campus



Conclusion

It is agreed that wastes is a direct result of human interaction and activities. Nevertheless, there seems to be several opinions as to what constitute a waste. The objective of the project was to analyses the effectiveness of the current waste management systems in SKUAST-K Shalimar campus. Solid waste management refers to all activities pertaining to the control, collection, transportation, processing and disposal of waste. Developing the solution of solid waste management it requires significant cooperation. As management programs are implemented, periodic waste stream assessments will be required to identify successful protocols as well as areas needing improvements.

The paper has revealed that institutional solid waste is not managed well at reflecting on the general situation in similar institutions in region. This is despite the potential for improvement on account of the institutions being single entities each of which is wholly under one authority and can thus be easily managed. Storage practices are poor in that in some cases bad storage facilities are used and in other cases no storage of waste is undertaken, waste is disposed of haphazardly on open land, aggravating the potential for

pollution. The potential for improvement has also been identified, especially the fact that institutions are relatively easy to manage due to each being under one authority and subject to some rules and regulations. Recovery of resources by way of the use of organic waste as animal feed or as feed material into compost or biogas production has been found to be potentially feasible. Resource recovery presents a potential waste reduction of between 71 and 86%. Per capita waste generation rates have been determined as 0.190, 0.193 and 0.083 kg cap−1 per day. The potential for improving the existing poor solid waste management practices lies in the possibility of instituting and enforcing a code of good waste handling practice in respect of waste management at institutional level. Also, the fact that residents in and users of institutional facilities are relatively more learned, add to the potential for improvement of solid waste management. For the envisaged improvement to work, the code of good waste handling practice must be put in place. Additionally, funding, expertise, equipment and facilities as well as other provisions that are currently lacking or inappropriate must be provided. Furthermore, since the envisaged solid waste management practices call for some behavioural changes, there is a need for community sensitization on pertinent issues.

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