Original Article

SOLID WASTE DISPOSAL MANAGEMENT IN A RESIDENTIAL COMPLEX OF A DEFENCE ESTABLISHMENT- A MODERN APPROACH

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ABSTRACT

Introduction: A study on "Solid Waste Disposal Management" was conducted as an AFMRC project at a flying defence establishment to design and implement newer scientific methods and techniques. The objective of the project was to reduce, reuse and recycle the generated waste for more eco-friendly and safe environment to live and fly.

Material and methods: A new module making use of newer methods and techniques was designed and implemented. Solid waste was collected in two segregated forms viz. biodegradable and non biodegradable at the household level and was transported in separate containers to the segregation site. Biodegradable waste was introduced into vermiculture ponds and non biodegradable waste was segregated into different components. At the end of follow up period of one year, a noticeable difference was observed in the hygienic conditions in the houses and surrounding environment.

Results: On an average a family produces about 556 gm of total solid waste, comprising of 419 gm of non-biodegradable and 137 gm of biodegradable components.Biodegradable waste was reduced to a very great extent and changed into highly fertile manure. Non recyclable items were disposed off by dumping, while recyclable items were segregated and reduced by crushing, shredding or cutting and were finally sold to the vendors to generate cash.

Conclusion: The AFMRC project "Solid Waste Disposal Management" has been found useful in controlling the problems of environmental sanitation. Similar projects may be undertaken at large scale to reduce, reuse and recycle the generated waste.

Key words: Household solid waste, bio-degradable waste, non biodegradable wastes, vermiculture, recycling of waste

INTRODUCTION

A study entitled "Solid Waste Disposal Management" was conducted for a duration of two years and six months at a premier flying Air Force defence base, as an AFMRC funded project. Main objective of the study was to review the existing waste disposal system, design and implement newer scientific methods and techniques to manage the household solid waste. These methods were intended to reduce, reuse and recycle the generated waste, to create more eco-friendly and safe environment, for living and flying at the Air Force base. The solid waste generated in the houses was collected, transported in a segregated manner and was treated by different modern scientific methods. Designing and use of the vermiculture ponds to reduce the biodegradable wastegenerated in kitchen was an innovative approach used for the first time. Construction of segregation bay and its use to segregate the non biodegradableitems in its different components was also developed and used scientifically. The knowledge and experience gained in the project work was also gainfully utilized at other defence bases to providebetter aesthetic look, improve their hygiene and sanitation conditions and to prevent the diseases.

MATERIAL AND METHODS

The study on "Solid Waste Disposal Management" was conducted at one of the premier flying bases, with the aims and objective to study the working of existing solid waste disposal system, design new methods of

solid waste disposal, implement these in the selected units of the campus and assess their merits.

1. **Selection of the sample and background preparations for the work**: Before beginning the actual field work following actions were executed for smooth conduct of the work:

a. Selection of the houses: The project was undertaken as a pilot study to see its effectiveness in the selected houses of the community of a flying defence establishment. Therefore a ten percent sample of the houses from two localities was selected for study.Out of total196 selected houses 102 were from Area I occupied by officers class and 94 from area II occupied by other ranks (airmen). Initially a survey of these houses was planned to find out the family structure, level of knowledge on waste and its disposal and impart them education on the project to seek their co-operation.

b. Education to the household members: After selection of the units, household members were given education by the supervisors of the project on importance of the project work and different other aspects like components of waste, biodegradable and non biodegradable waste items, segregated collection in the bins and different stages of its disposal.

2. Existing system of Solid Waste Disposal: To study the existing system of Solid Waste Disposal the selected houseswere visited by the representatives of medical establishment to collect the information. Following were the conclusions drawn:

a. Collection of waste in the houses: A metallic foot operated waste bin named receptacle with bucket supplied by Medical Engineering Services (MES) is in use. This bin is used for collection of the generated waste in mixed form in the houses.

b. Common collection of waste at a site near houses: The contents of the receptacle are emptied in a masonry structure called swill bin. These bins are located at central place at walk able distance from all the houses. Most of these bins are open from top and are accessible to the animals and rodents. The contents from the bin are taken out at times by the animals and rodents, which litter the surroundings. If the waste is not picked up the same day, it begins to smell due to decay.

c. Final disposal of the collected waste: The mixed waste is collected from swill bins manually by the conservancy people in the mixed form and is taken to a landfill ground located at a distance of 5-6 kilometres away from the locality. Frequency of collection varies from daily to once in three days.

3. Designed Solid Waste Disposal Management System: After studying the existing Solid Waste Disposal System and review of the available literature on the subject, a new Solid Waste Disposal Management System was designed by incorporating certain methods to make it more eco-friendly and safer for flying. The designed method consisted following components:

a. Collection of the waste generated in the houses: All selected units of the station were provided with a set of two coloured plastic bins with covers. A red coloured bin of the size of 20 litres meant to collect non-biodegradable waste and a green coloured small bin of 5 litres capacity for biodegradable waste. These were centrally procured and issued to the housing units. The work of segregation at household level, its collection, transportation, reduction and disposal started from 21 May 2002 and continued for a period of one year. To observe the variation in quantity of the generated waste the complete period was divided in four quarters, each of three months.

b. Transportation of the waste to the segregation bay: Waste generated by the units was collected in similar colour coded containers by the conservancy workers employed by the station. This was transported to the segregation bay and vermiculture pond in cycle rickshaw specially designed for the purpose. Segregation bay was constructed as a big masonry structure having a flat top for segregation of the items and six chambersbelowto store them.

c. Reduction of the waste: The waste received at the central place was reduced in following manner:

1) Bio-degradable waste**:**Four big chambers (pits), eachof the size 6 ft X 3 ft X 3 ftwere dug in the ground to be used as vermiculture ponds. At the base of each chamber a layer of about 6 inches,consisting of a mixture of sand, soil, predigested leaves and cow dung was laid. To this layer a specific earthworm Eiseniafoetida was introduced to grow. Biodegradable waste generated mostly as kitchen waste was weighed every day after removing harmful contents from it which are known to cause harm to the worms like citrus fruits and containers of detergents and acids etc. Thereafter the waste was allowed to dry for a day or two to reduce its water contents before its introduction to vermiculture pond which had been introduced with the worms earlier. All chambers were used in succession with a reduction period of 2-3 months. After this period the contents were removed and used in the station gardens as manure.

2) Non bio-degradable waste: Non biodegradable waste was placed on the top of the segregation bay and was manually segregated. The reusable or recyclable items were dropped in different chambers below. The leftover non useful items were collected separately and sent for dumping. The segregated items i.epapers, metals, glass, plastics, polybags and card boards were reduced in volume by crushing or shredding by the mechanical devices i.e. crusher and shredder. Items then were placed in big gunny bags for selling.

d. Final disposal of the waste: Category of non usable items out of non bio-degradable ones were dis-

posed off by dumping in the low landfill areas located at a distance of six kilometres away from the station.The reduced recyclable items were sold to the garbage vendor at the prevalent rates.The quantity of biodegradable waste was reduced largely and was converted into manure and used in the gardens of the station.

RESULTS

Out of 196 houses selected in all, 102 and 94were respectively from officer and other ranks categories, located in different areas of the station. In the initial survey of these houses,overall family size was worked out to be 3.37, with 2.97 members in officerclass and 3.81 in other ranks.Only 37 heads of the family (18.87 %) had knowledge of segregation of waste as biodegradable and non biodegradable, mostly (14.79 %) from the officers' class. The results of solid waste management are presented quarter wise as under:

Table-1 shows practice of segregation of waste adopted by number of houses quarter wise per day. It is evident that in first quarter only 49 (34.75 %) out of the visited 141 hoses followed the practice of segregation. It improved markedly in second quarter to 88 (56.08%)and thereafter gradually in subsequent quarters to 96 (64.42%) and 121 (74.69%) In the last quarter, there were only 41 (25.30%) houses, which could not adopt the practiceof segregation despite or repeated instructions by supervisory staff. Since the amount of segregated waste increased in every quarter as the work progressed, quantity of non segregated (mixed) waste reduced proportionally from 65.24 to 25.30 percent.

Table 1: Quarter wise practice of segregation of waste at household level

Quarter	Segregated Houses (%)	Non segregated Houses (%)	Total Houses (%)
I	49 (34.75)	92 (65.24)	141 (71.93)
II	88 (56.08)	69 (43.94)	157 (80.12)
III	96 (64.42)	53 (35.57)	149 (76.02)
IV	121 (74.69)	41 (25.30)	162 (82.65)
Average	**88.5 (58.12)**	**63.75 (41.78)**	**152.55 (77.67)**

Table-2: Quarter wise average quantity of different types of wastes collected per day

Quarter	Quantityof two types of waste (in kilograms and percentage)			Houses practiced segregation	Quantity of two types of segregated waste (in kilograms and percentage)	
	Total	Non Segregated	Segregated		Bio-degradable	Non biodegradable
I	75.71	49.45 (65.31)	25.75 (34.75)	49	6.06 (23.53)	19.69 (76.46)
II	89.80	38.27 (42.61)	51.53 (56.08)	88	13.87 (26.91)	37.66 (73.08)
III	87.01	30.45 (34.99)	56.56 (64.42)	96	14.40 (25.55)	41.96 (74.44)
IV	85.21	21.25 (24.93)	63.96 (74.69)	121	14.15 (22.15)	49.73 (77.84)
Average	84.43	34.98 (41.43)	49.45 (58.56)	**88.5**	12.12 (24.63)	37.08 (75.36)

Table-3: Quantity of two types of segregated waste generated per house per day

Quarter	Total kg	Biodegradable kg (%)	Non biodegradable Kg (%)
I	0.525	0.123 (23.42)	0.402 (76.58)
II	0.585	0.157 (26.83)	0.428 (73.16)
III	0.589	0.152 (25.80)	0.437 (74.19)
IV	0.528	0.117 (24.64)	0.411 (75.35)
Average/day	**0.556**	**0.137 (24.64)**	0.419 (**75.35**)

Table-2 shows the quantity of two types of waste collected from the houses. In first quarter of the follow up period, out of the collected total waste (75.71 kg), only 25.75 kg (34.01%) was segregated at the point of generation. Rest 49.96 kg of waste was collected in a mixed form. As the work progressed and the supervisory staff repeated instructions, the quantity of segregated waste improved to 63.96 kg (75.06%) and the quantity of non segregated waste decreased proportionately to 21.25 kg (24.93%) in the last quarter. The quantity of total waste collected per day ranged between 75.71 and 89.80 kg with an average of 84.43 kg. Maximum effect of the instructions was seen in the second quarter wherein quantity of segregated waste improved more than two times. Thereafter the improvement was gradual.

Table-3shows the quantity of two fractions of the segregated wastes (i.e. biodegradable and non biodegradable) generated per day per house. The quantity of total waste ranged from 0.525 kg in first quarter to 0.589 kg in third quarter with an average of 0.556 kg. Out of this total waste, the component of biodegradable waste was 0.123 kg (23.42 %) in first quarter, 0.157kg (26.83 %) in second, 0.152 kg (25.80 %) in third and 0.117 kg (24.64 %) in fourth quarter with an average of 0.137 kg (24.64 &). With an average of 0.419 kg (75.35 %) of the non biodegradable waste, its quarter wise collection was 0.402 kg (76.58 %) in first quarter, 0.428 kg (73.16 %) in second, 0.437 kg (74.19 %) in third and 0.411 kg (75.35 %) in fourth quarter. Quantity of biodegradable waste generated in II and III quarter was more (winter months) as compared to I and IV quarters.

Table-4 shows the quarter wise quantities of different fractions of the segregated non bio-degradable wastes. Out of the total quantity of 16701 kg of non biodegradable waste the quantity of recyclable and non recyclablewaste was 1575 and 14538 kg. An additional quantity of 588 kg was although recyclable but was taken by vendor without any payment considering it useless. The same was categorised as other waste.

Table-4: Quantities (in kilograms) of different fractions of non biodegradable waste

Types of waste	Qtr-1	Qtr-2	Qtr-3	Qtr-4	Total
A. Recyclable	**219**	**378**	**452**	**526**	**1575**
(i) Paper/book etc	24	44	67	82	217
(ii) Metallic items	19	33	45	69	166
(iii) Glass items	61	98	116	133	408
(iv) Plastic	39	73	88	104	304
(v) Poly bags	13	21	23	17	74
(vi)Card boards	63	109	113	121	406
B. Non Recyclable	**2299**	**3548**	**4091**	**4600**	**14538**
C.Others	**25**	**173**	**188**	**202**	**588**
Total	**2543**	**4099**	**4731**	**5328**	**16701**

On quarter wise analysis it was found that there had been about two time increase in the quantities of almost all items when a comparison was made. This was due to repeating of the instructions by the supervisory staff and making the beneficiaries understand the utility of the system about segregation of the waste at point of generation. On selling these items there was a total earning of rupees 3099. This although appears a meagre amount as compared to the investment but the benefits of the system in terms ofmaintaining of high standards of cleanliness and reducing the chances ofdiseases may be considered more valuable.

DISCUSSION

Man amidst the environment remains exposed to a variety of components which are likely to affect his health. Waste generated in his routine activities is an integral part of the life that needs to be disposed offwith care and safety. If not taken care, it may give rise to undesirable look, disagreeable smell and many health related problems. Ways adopted to maintain cleanliness in and around the houses reflect the development of a society. The residential societies of the defence establishments by far are very well maintained with a very little scope for improvement. Presentresearch work was oriented to develop methods for further improvements in the existing system of waste disposal.

The existing system of solid waste disposal in vogue, comprised of collection and disposal of the generated waste in a mixed manner without its segregation at the place of its generation. This simple system can work well if biodegradable waste is not allowed to stay at one place for more than a day. The after effects arising due to decay of such waste gets transferred to the place of its final disposal. Moreover, non biodegradable wastespoilt by the biodegradable waste, thus the only way left is its final disposal by dumping or burning.

In first quarter of the work, only 34.75 % of the household were able to adopt the methods of segregation, but their percentage increased to 74.69 % in last quarter. This was either due to non acceptance of the method or theirinability to understand the system and its importance. Out of the total average quantity of collected segregated waste per housewhich was 0.525 kg, the amount of biodegradable waste was 0.137 kg (24.63 %) and that of non biodegradable waste was 0.419 kg (75.36%).Considering the average family size of 3.37 persons, it works out to be 40.65 gm and 124.33 gmrespectively per person per day.This means about 40 kg of biodegradable and 125 kg of non biodegradable waste will be generated per day by a community of 1000 persons. If biodegradable waste is segregated at the point of household collection and is disposed off same day, the problems arising due to its decay like disagreeable smell, house fly and insects breeding and harbourage of rats and animals, can be easily tackled. Collection of non biodegradable waste and its disposal may be deferredby a couple of days as it is not harmful if not spoiled by biodegradable waste.

The biodegradable waste generated in the kitchens was effectively reduced to a great extent by the method of vermi-composting and the residue so produced wasfound highly nutritious for the plants as manure. Although it was in great demands, it was not sold for use by the farmers to assess its usefulness through local gardens.

Out of the total 16701 kg of non biodegradable waste collected during the period of study, the quantity of non recyclable waste was 15,126 kg that contributed to 87.04 percent. It was sent to the low land area for its final disposal as dumping.The recyclable waste was 2163 kg (12.95 %) which was further segregated into different components i.e. glass (408 kg), cardboard (406 kg), plastics (304 kg), papers (217 kg), metallic items (166 kg) and poly bags (74 kg). These were reduced in volume by the processes of crushing (glass), shredding (plastics) and cutting (card board and papers). Most of these items 1575 kg were sold to the vendor while few 588 kg were given without taking money in exchange. An amount of rupees 3099 was earned by selling these items with an average exchange of rupees 1.96 per kilogram. Most toxic out of all these items are plastics and poly bags which emit dioxin and furans on burning, known to cause harmful effects on human beings in the form of malignancies. Since facility for incineration of the waste was not available in the station method of dumping was preferred to burning. If an incineratot could be installed in the station the household non biodegradable waste after segregation of recyclable waste can be incinerated locally.

The study was also intended to observe the seasonal variation in the generated quantity of waste, but it could not be assessed. The reason for this had been a large variation in the quantities of wastes generated in different quarters because of to time taken by the users in accepting the system.

CONCLUSION

The AFMRC project entitled "Solid Waste Disposal Management" was conducted at one of the premier flying Air base with an intention to reduce the environmental sanitation problems arising due to unsafe disposal of generated solid waste in the houses. The methodology developed to conduct the research work has been implemented well to see its effectiveness and compare it with the existing system of waste disposal. The work done has produced a base line data on different components of the waste in terms of biodegradable, non biodegradable, non recyclable, recyclable. Considering the work as innovative, more projects may be undertaken on larger scale to strengthen the Solid Waste Disposal System in the societies for improvement of environmental sanitation. This may go a long way inreducing the burden of health problems arising due to improper sanitation.

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