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Rural Solid Waste Management

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ABSTRACT: The province of Bushehr is located in southern area of Iran and north of Persian Gulf. Solid waste management in Bushehr's villages was the aim of this research. For the sake of this study, 21 villages scattered all over the province were selected. Field studies showed that about 646 grams of residential solid waste per capita is generated in selected villages every day. There are 322 shops in chosen villages and total amount of commercial waste is about 3565 kilograms per day. The average amount of medical waste is about 7.8 kilograms per hygienic unit. Waste Composition in selected villages is: putrescible materials: 42.49%, construction and demolition: 11.7%, paper and cardboard: 8.77%, plastics: 8.24%, wood: 6.90%, metal: 6.08%, glass: 5.89%, rubber and leather: 5.1% and textile: 4.83%. According to this study, the main obstacle to recycling program is the unbiased collection of waste in rural area. It is recommended that for the first five year program, source separation includes degradable matter and dry wastes (paper, plastics and metals). Source separation of other components such as wood, rubber, glass and textile can be carried out in the second five year program. From the economical point of view, incineration with energy recovery can not be a good alternative for rural waste disposal in Bushehr province. Due to the low volume of degradable matter, land availability with low cost and easy access to labor force in rural areas, low cost technology composting is recommended. The quantity of waste generated in each village is not sufficient to be managed separately, thus a regional solid waste management must be defined to include adjacent villages.

Key words: Solid waste, Management, Rural, Bushehr, Iran

INTRODUCTION

Environmental and public health awareness in Iran have resulted in national legislation concerning solid waste. The first solid waste law was passed in 2003. According to paragraph ten of this law the Ministry of Interior (MoI) is responsible government official for municipal and rural solid waste management in Iran. Government official, responsible for solid waste collection and disposal in rural areas is known as Dehyari. Dehyari has poor resources to meet the requirements of this law and as Fakayode (2005) and Gunattilaka (2006) have indicated, in many developing countries, environmental laws are rarely observed (Rafee *et al.*, 2008). To facilitate the implementation of this law , MoI has initiated some research projects to build up the knowledge of solid waste collection and disposal alternatives that may be beneficial to Dehyaris and community leaders.The province of Bushehr with an area of 22,473 square kilometers is located in southern area of Iran and north of Persian Gulf, between latitudes 27° 14' and 30° 16' N, and longitudes 50° 06' and 52° 58' E. According to 2006 divisions, Bushehr consists of 8 provincial towns, 22 districts, 29 cities and 43 rural districts (Statistical center of Iran, 2006). In 2006, the number of villages in this province was 691. In the year 2006, Bushehr province had a population of approximately 744,000, of which nearly 53.1 % resided in urban areas, 44.8 % accounted for rural regions and the remaining were non-residents (Statistical center of Iran, 2006). The location of Bushehr province is shown in (Fig. 1).

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MATERIALS & METHODS

Both determining the present status of solid waste management in Bushehr's villages and

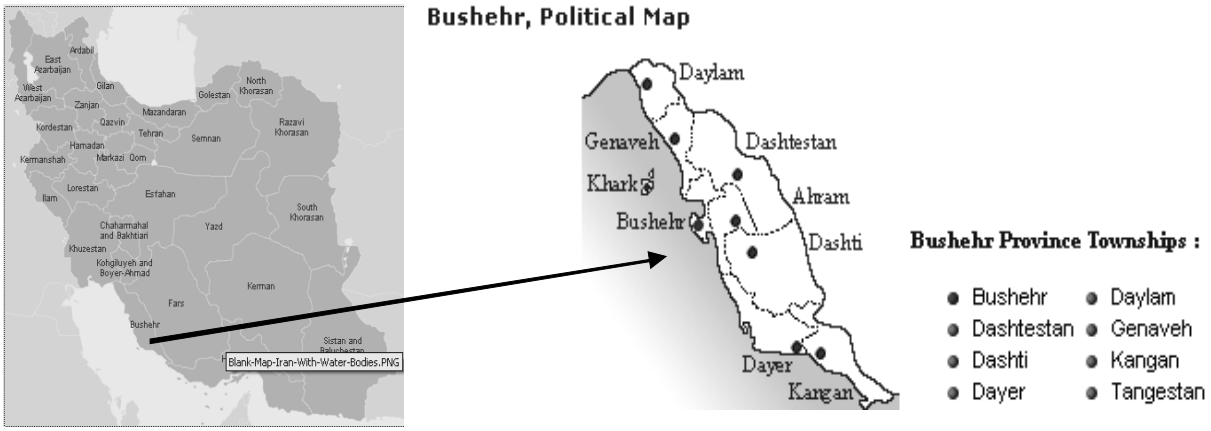

Fig. 1. Location of Bushehr province

recommending appropriate systems to handle the waste, require desk and field study. For the sake of this study, 21 scattered villages all over the province were selected. A questionnaire consists of open-ended and closed-ended questions which addresses the current status of solid waste disposal in rural area, was developed. This questionnaire was administered to all 21 Dehyaries. Information obtained from each questionnaire was complemented by interviewing responsible government Officials for solid waste management in Bushehr province in relevant departments. Waste sampling was carried out during the 2006 for seven successive days in the middle of the four seasons. On each sampling day, 65 samples of 1 m^3 volume were taken from specified homes in each of the 21 villages. Sampling and samples Preparation were conducted according to the ASTM D5231-92 for chemical and physical analysis of refuse and compost (ASTM, 2003).

RESULTS & DISCUSSIONS

Solid waste is the result of human activities (Abduli, 1997). If an appropriate management system isn't used for this problem, it may lead to environmental pollution and jeopardize the mankind's health. (Jalili & Noori, 2008). The activities associated with the management of solid waste from the generation point to final disposal have been grouped into six functional elements including: waste generation, storage, collection, transfer and transport, processing and Recovery and disposal (Tchobanoglous *et al.*, 1993). For the time being, Waste generation, collection and disposal are the existing three functional elements of Solid Waste Management System (SWMS) in Bushehr.In order to formulate an integrated solid waste management program for a community, accurate and reliable data on waste composition and quantities are essential (Pichtel, 2005). There are seven major classifications of solid waste generators: residential, industrial, commercial, institutional, construction and demolition, medical and agricultural. In the area of study, solid waste generators are: residential, commercial and medical units. About 646.43 grams solid waste per capita is generated in residential area of these 21 villages in Bushehr every day (Table1). There are 322 shops in chosen villages and total amount of commercial waste is about 3565 kilograms per day. The average amount of medical waste is about 7.8 kilograms per hygienic unit. The wastes that are generated from different sources are mixed and collected together (Abduli *et al.*, 2007).

The field study assessed the physical and chemical characteristics of the solid waste stream in all 21 villages. (Table 2). presents the average percentages of the different components of waste stream in 21 villages in 2006. (Table 3). shows C/N ratio, Chemical formula and heat value of solid waste in 2006.The handling, storage and processing of solid waste at the source, before they are collected, are the second element of six functional elements in the solid waste management system. There is no on site handling, storage and processing of solid waste neither in rural area of Iran nor in villages of Bushehr. Containers used for on-site storage in these villages includes: plastic bags, plastic bins and oil drums made of low-grade tinplates. Waste separation is accomplished only

Table1. Residential solid waste generation rate and population in 21 major villages of Bushehr (2006)

No.	Town	Village	Population	Average residential generation rate (g/ca.d)
1	Bushehr	Doveyrah	2619	1057.5
2		Tal ashki	605	577.5
3		Chah kutah	1695	930
4	Tangestan	Abtavil	1259	617.5
5		Abad	3335	952.5
6		Alyhosseini	2062	550
7		Khurshahab	1079	467.5
8	Dashtestan	Jatut	1055	500
9		Chaharborj	1364	952.5
10		Dehghayed	5668	797.5
11	Dashti	Ziyarat	2818	510
12		Bonyad	876	522.5
13		Derazi	1446	442.5
14	Dayer	Lombedane- bala	891	662.5
15		Shahniya	1589	477.5
16	Deylam	Ameri	1114	452.5
17	Kangan	Teshan	1397	645
18		Bidkhun	6000	797.5
19		Anarestan-e-jam	2089	732.5
20	Genaveh	Shul	1285	445
21		yuzgah	552	485
Average				646.43

Table 2. Composition of solid waste generated in selected villages (2006)*

Season	Putrescible materials	Construction and demolition	Paper and Cardboard	Plastics	Wood	Metal	Glass	Rubber and leather	Textile
Spring	48.57	5.13	8.47	9.02	7.64	6.31	5.73	4.31	4.82
Summer	40.51	12.9	8.6	7.85	5.55	7.07	6.44	5.72	5.36
Fall	40.91	13.97	8.36	8.29	7.12	5.65	5.89	4.74	5.07
Winter	39.97	14.81	9.64	7.79	7.28	5.3	5.5	5.63	4.08
Average	42.49	11.7	8.77	8.24	6.90	6.08	5.89	5.1	4.83

***percentage by weight**

in 26.7 percent of selected villages which in tow villages, separation process are done by scavengers and in two villages it is done by the collection workers. Collection is the main and in most of the time the only activity of rural SWMS in Bushehr. More than 90 percent of total cost is attributed to the collection of solid waste (Abduli and Nasrabadi, 2007). According to the prepared questionnaires, approximately 70 percent of the chosen villages have some sorts of waste collection systems. Collection in these villages is very primitive. Types of collection service which commonly used are curbside collection and direct delivery. Collection Labors call on the houses and gather their solid wastes. Collection frequency depends on financial aspects of Dehyari and the willingness of villagers for payment. Collection frequency varies in one to six times a week. Collection frequencies in these villages are: 9.1 percent once a week, 36 percent twice a week, 36 percent three times a week and 18.9 percent six times a week (weekdays except Friday).

In 85 percent of these villages, waste collection is undertaken by Dehyari. In 15 percent of them, collection is done by village council. Door to door collection is the only method in 92 percent of cases.

Table 3. C/N ratio, chemical formula and heat value of solid waste in selected villages (2006)

No.	Town	Village	Chemical Formula	C/N	Dry dolang heat value(kj/kg)	Wet dolang heat value(kj/kg)
1	Bushehr	Doveyrah	$C_{1204.5}H_{1822.2}O_{448.2}N_{27}S$	38.2	10388	6691
2		Tal ashki	$C_{688.8}H_{1063.8}O_{279.7}N_{17.1}S$	34.6	5924	2414
3		Chah kutah	$C_{1366.4}H_{2072.5}O_{489.9}N_{28}S$	35.6	9678	5438
4	Tangestan	Abtavil	$C_{814.6}H_{1244.5}O_{332.8}N_{20.5}S$	34.1	7953	3838
5		Abad	$C_{1165.9}H_{1772.7}O_{421}N_{27.1}S$	36.9	10816	6777
6		Alyhosseini	$C_{733.8}H_{1141.3}O_{371.7}N_{17.6}S$	35.8	9430	5393
7		Khurshahab	$C_{625.5}H_{968.6}O_{339.6}N_{16.7}S$	32.2	7252	3564
8		Jatut	$C_{616.6}H_{950.2}O_{294.9}N_{19.4}S$	27.3	7925	3384
9	Dashtestan	Chaharborj	$C_{939.4}H_{1420.5}O_{374.7}N_{21.7}S$	37	10668	5589
10		Dehghayed	$C_{893.5}H_{1367.6}O_{365}N_{21.1}S$	36.4	9623	5179
11	Dashti	Ziyarat	$C_{1021.7}H_{1577.1}O_{484.5}N_{10.6}S$	82.6	12417	8916
12		Bonyad	$C_{518.9}H_{801}O_{270.3}N_{16}S$	27.7	6130	2227
13		Derazi	$C_{964.9}H_{1448.2}O_{488.2}N_{24.5}S$	33.7	10640	7328
14	Dayer	Lombedane balaee	$C_{924.8}H_{1419.4}O_{336.7}N_{23}S$	34.4	9966	5160
15	Deylam	Shahniya	$C_{1404.9}H_{2122.2}O_{469.3}N_{27.5}S$	43.8	12483	8167
16		Ameri	$C_{786.9}H_{1212.4}O_{352.2}N_{20.5}S$	32.9	9373	5092
17	Kangan	Teshan	$C_{732}H_{1126.9}O_{316.8}N_{19.2}S$	32.7	8344	3895
18		Bidkhun	$C_{753.1}H_{1162.8}O_{295.7}N_{19.5}S$	33.2	8073	3651
19		Anarestan-e-jam	$C_{899.7}H_{1366.4}O_{417.8}N_{18.2}S$	42.4	8241	4650
20	Genaveh	Shul	$C_{582.2}H_{896.3}O_{312.6}N_{13.7}S$	36.4	7440	3034
21		Puzgah	$C_{897.4}H_{1375.9}O_{381.3}N_{22.3}S$	34.5	9514	5548

The other collection methods accounts for the remaining 8 percent. In 17 percent of villages collection is undertaken voluntarily. In 33 percent of the villages, wastes are collected by the private sector. Waste collections for 50 percent of the villages which are located near the cities are carried out by the municipalities. Collection devices in 6.7, 13.3, 33.3, 20 and 20 percent of villages are wheelbarrow, wagon, Nisan van, tractor and truck, respectively. Animal waste in 15.5 percent of cases is mixed with domestic wastes, in 53.8 percent is used as fertilizer, in 26.9 percent is sold and in 3.8 percent is disposed on any available piece of land in the vicinity of household. Rural waste management in this province consists of collection and land disposal or open dumping of waste on the ground. Therefore equipments and technologies used in rural waste management are limited only to collection equipment. These equipments and machineries are: wheelbarrow, wagon, truck, van, trailer and tractor.

Disposal is the last functional element in solid waste management system. Disposal is the ultimate fate of all solid waste (Vesilind *et al.*, 2002). The most common methods recognized for the final disposal of solid waste in rural areas in Bushehr are: dumping on land, open incineration and plowing in to the soil. In general open dumping is a common method of waste disposal for rural areas in Bushehr. Disposal of wastes in chosen villages is consisted of: 25 percent open dumping, 8.3 percent use as animal and poultry food, 8.3 percent dispersion in pastures as fertilizer, 41.7 percent dumping and burning and 16.7 percent burying in the ground. Public participation in 52.9 percent of chosen villages was very satisfactory, in 35.3 percent was average, and in 11.8 percent was poor. In 75 percent of villages, people are discontented and only in 25 percent of the villages they are contented for waste management. In 78.6 percent of chosen villages, the villagers pay for the collection, and disposal of wastes. On monthly basis, average cost of mentioned activities for

these villages is one US dollars. In 21.4 percent of villages, the villagers don't pay any direct expenses.

CONCLUSION

The main obstacle for recycling program is the unbiased collection of waste in rural area. Degradable matters, paper, plastic and metal are the main components of rural waste of Bushehr province. It is recommended that for the first five year program, source separation includes degradable matter and dry wastes (paper, plastic and metal). Source separation of other components of wastes such as wood, rubber, glass and textile can be carried out in the next five year program. While incineration reduces the volume and can recover energy, it can also have some risks associated with it (Heng *et al.,* 2008). From the economical point of view, incineration with energy recovery can not be a good alternative for rural waste disposal in Bushehr province. Due to the low volume of degradable matter, land availability with low cost and easy access to labor force in rural areas, low technology composting is recommended. Low-level technology includes leaves, grass clippings, and brush to make compost. The material is shredded, wetted, and piled into windrows approximately 6 feet high and 12 to 14 feet wide (Strom and Finstein, 1986). Enough water is added to maintain a moisture content of near 50 percent. After the pile has stood for a week, temperatures within the windrow should reach 140° to 160° F (Frigden and Rahman, 1990). The windrow is then turned once every three to four months, with a completion time of nine to twelve months; depending on the number of times it is turned.

Equipment needs for this process include a front loader to make and turn windrows and a grinder, which is used to grind brush and limbs into a uniform size and consistency. A new grinder costs from $20,000 to $100,000, depending on the size and features of the grinder. Planners should be sure to purchase a commercial quality grinder with enough capacity to handle future volume increases (Goodwin *et al.,* 2006).This level of composting technology is the most common in the U.S. today and produces quality compost, while maintaining a relatively low cost. Its only major disadvantage is the length of time it takes to complete the compost (Goodwin *et al.,* 2006). Agricultural and animal wastes could be composted with these facilities too. Because of the seasonal changes in quantity of agricultural and animal wastes, it's necessary that the capacity of composting systems and related equipments be flexible and can absorb fluctuations of waste generation. So it is preferable to use flexible composting facilities. The quantity of waste generated in each village is not sufficient to be managed separately, thus a regional solid waste management must be defined to include adjacent villages. Of course collection of wastes must be carried out by each Dehyari in each village. Waste recovery and disposal should be managed regionally.

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