Journal of Sustainable Development in Africa (Volume 22, No.1, 2020)
ISSN: 1520-5509
Clarion University of Pennsylvania, Clarion, Pennsylvania

A SURVEY OF PATTERN AND DETERMINANTS OF RURAL HOUSEHOLDS' CHOICE OF SOLID WASTE DISPOSAL METHODS IN OGUN STATE, NIGERIA

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ABSTRACT

The generation of solid waste and its disposal are important for human health and sustainable environment. This study was designed to examine the pattern and determinants of rural households' choice of solid waste disposal methods in Ogun State, Nigeria. Data were collected from 240 households selected through multistage sampling techniques using semi structured questionnaire. Descriptive statistics and multinomial logit regression model were used for data analysis. The results revealed that majority (63.3%) of the respondents were male with a mean age of 36 years. Burning, open dumps, government agencies, burying and landfill were the major methods of waste disposal in the study area. Household head's age, sex, marital status, education, household size, occupation and distance to centralized dumb sites were the determinants of rural households' choice of solid waste disposal methods in the study area. Recycling, incineration and composting are therefore recommended as sustainable approaches for waste disposal in the study area.

Keywords: Choice, Determinant, Pattern, Solid waste disposal, Rural households

INTRODUCTION

Solid wastes could be defined as non-liquid and non-gaseous products of human activities which must be disposed of, because they lack direct value to the users. It could take the forms of refuse, garbage and sludge (Leton & Omotosho, 2004; Babatola, 2008). Globally, about 1.3 billion tons of solid waste are generated annually, 32 million being generated by Nigeria, out of which 85.8% is generated by households and only 20–30% is collected by paid private or government agencies (Adeyemo & Gboyesola, 2013; Ogundele, Opeagba, & Amusat, 2018). The solid waste types generated from household, agricultural, commercial, education, and industrial establishments in Nigeria include food remnants, vegetables, garden waste, paper, nylon, wood, dust, cloth, metal scraps, electronic gadgets, bottles, saw dust, ashes, rubber, bones and plastics (Babayemi & Dauda, 2009). Uncollected waste, indiscriminately disposed in open spaces, water bodies, storm-drainage channels, buried, burnt or dumped along the streets or roadsides constitute a disaster to human health and lead to environmental degradation, contamination of water bodies, blockage of sewers and drainage networks. Blocked drainage channels as a result of improper dumping of refuse can cause flooding. (Achankeng, 2003; Ojo, 2014). According to the United Nations Environment Program Agency (UNEPA, 2006), improper waste management, especially solid waste from households and the community are a serious environmental and health hazard that can lead to the spread of infectious diseases. Also, Leachate from uncollected and decomposed garbage waste can contaminate groundwater and this could have enormous health implications in low-income communities where the use of well-water for drinking is common (UNCHS 1988; Ogundele, et al., 2018).

Various methods of waste disposal includes: landfill: which involves burying the waste in abandoned or unused quarries, mining voids or burrow pits and covering it with layers of soil; incineration: involves subjection of solid organic wastes to combustion at a very high temperature of about $10{,}000^0$C so as to convert them into residue or gaseous products; open dumps: involves dumping on open land, rivers or sea; composting: this is an aerobic, biological process of degradation of biodegradable organic matter; hog feeding: this involves feeding animals like pigs with left over materials of waste; mechanical destructor: this involves the use of machines to destroy waste materials; recycling: which means taking waste materials and transforming them into raw products, results in saving natural resources, saving energy, reducing disposal costs, reducing harmful emission to air and water, saving money and creating jobs (Anthea, Hopkins & Johnson 1994; Wikipedia Conserve Materials; Adogu, et al., (2015)). Nwofe (2015) divided the municipal solid wastes in Abakaliki metropolis to biodegradable (food scraps, worn-out clothes, ash, vegetables, leaves, wood, used cartons, and so on) and non-biodegradable (polythene bags, sachet water bags, rubber items, plastics, bottles, cans, worn-out tyres, and so on). They further reported that the major methods of disposing these solid wastes were authorised and unauthorised waste dump site, open burning and land fill. Sustainable waste management is a major challenge in Nigeria and failure to duly address it can pose serious threat to the residents (Cheever, 2011). The problem is much complicated due to increased population growth, urbanization, increased economic activities, lack of training in modern waste management practices, inadequate human and financial resources; facilities, infrastructure and technologies (Ahsan, et al., 2014; Kebede & Tolossa, 2019).

Ogun State, just like most states in the country, generates several tons of municipal solid waste which are left uncollected at the designated and undesignated waste dumping sites each day. These unattended heaps of waste according to Nwofe (2015) leads to; clogging of drains and gutters, creating feeding ground for pests that spread disease thereby generating a

myriad of related health and environmental problems, the solid wastes in most cases are being blown around by winds or rainstorm making the environment dirty, and air pollution arising from the decay of these waste to emit poisonous gases to the environment. This could also increase the volume of greenhouse gases (GHGs) in the atmosphere and consequently increase the risk of climate change (Nwofe, 2015). This therefore necessitated the present study on pattern and determinants of rural households' choice of solid waste disposal methods in Ogun State, Nigeria. Specifically, the study sets to identify common methods of waste disposal adopted by the households in the study area and determine the socio-economic factors influencing household's choice of waste disposal methods in the study area

METHODOLOGY

Study Area

The study was carried out in Ogun State, Nigeria. The state is one of the six states in southwestern Nigeria, created in 1976. Abeokuta is its capital. It lies within latitude 6°N and 8°N and longitude 2° E and 15° E. The state shares boarders with Lagos State to the south, Oyo and Osun States to the north, Ondo State to the east and Republic of Benin to the west. It has a population of 3,751,140 according to 2006 census and covers a total land area of 16,409.26 sq. km. The state is made up of twenty Local Government Areas (LGAs), endowed with good weather favourable for farming activities. The inhabitants of the rural areas are predominantly farmers. The major crops grown are maize, cassava, rice, pineapple, cocoyam and cash crops like kolanut, oil palm, rubber and timber, among others.

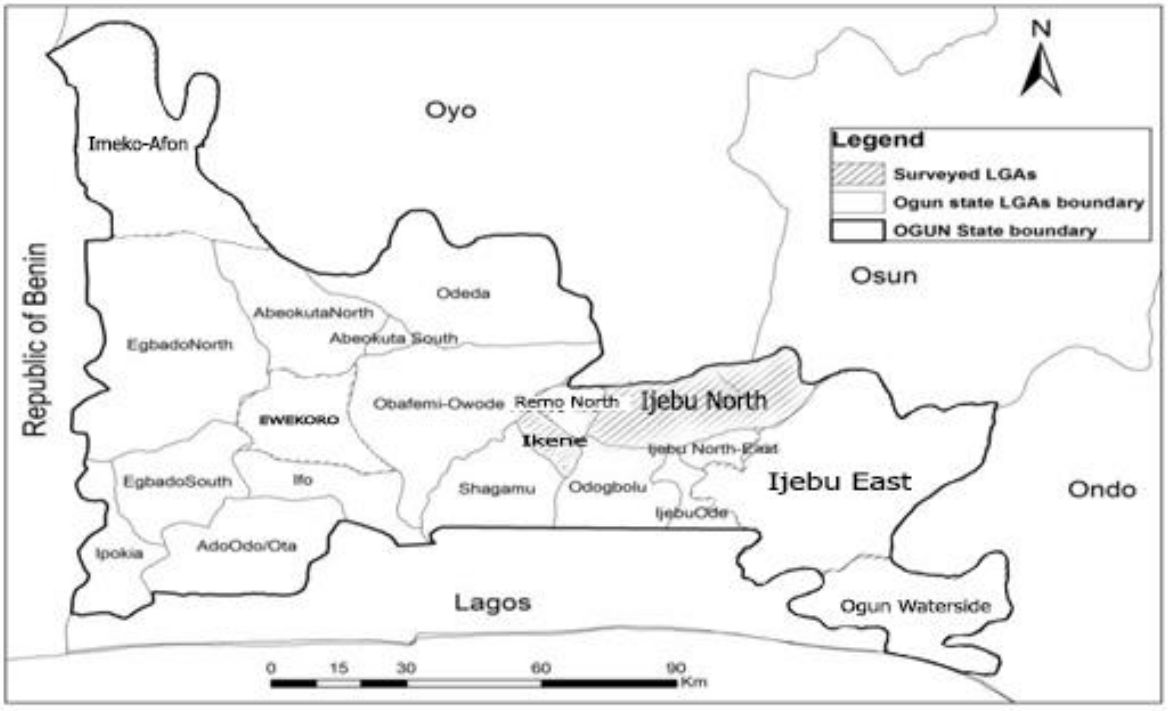

Figure 1: Map of Ogun State showing the study area

Sampling Procedures

The data for this study was obtained from cross sectional survey of rural households in Ogun State using multi-stage sampling technique. First stage involved the random selection of two LGAs in the state. In the second stage, simple random sampling technique was used to select six communities from each of the selected LGAs making a total of 12 communities. In the last stage, 20 households were randomly selected from each of the communities making a total of 240 respondents for the study.

Data for this study were collected through primary source, with the aid of semi structured questionnaires which focused mainly on socio-economic characteristics of the respondents and methods of waste disposal in the study area.

Analytical Techniques:

Multinomial logit regression model was used to determine the socio-economic factors influencing the households' choice of solid waste disposal methods in the study area. The multinomial logistic regression model is a discrete choice model that describes the behaviour of decision makers such as people, households and firms when faced with making a choice from more than two alternatives (Train, 2009). The model used for this study was adopted from Arowolo, et al., (2018). In the study area, there are various waste disposal methods from which the rural households have been observed to choose. A household *n* chooses from a set of mutually exclusive waste disposal choices, $j = 1\ldots., J$ and derive a certain level of utility U_{nj} from each of the chosen alternative. It is hypothesized that a decision maker's choice of an attribute is determined by a vector of socio-demographic characteristics such as age, sex education, income, distance to dumb site, and so on. Thus, for the n_{th} household faced with j_{th} choice, the utility function can be specified as:

$$U_{nj} = \beta' x_n + \boldsymbol{\varepsilon}_{nj}, \ \ j = 0,1,2,3. \quad (1)$$

Where n indexes the household, j indexes the waste disposal method choices, β' represents the coefficients' vector, x_n is a vector of households' socio-demographic characteristics, and '$\boldsymbol{\varepsilon}_{nj}$' are the model disturbances that are assumed to be independently and identically distributed with extreme value distribution (Greene, 2002).

In this study, the dependent variable, the households' waste disposal method is defined over a set of five exhaustive alternatives labelled as 0, 1, 2, 3 and 4 representing government/paid agency, landfill, burning, burying and open dumps respectively. Discrete choice models are based on the assumption that consumers are rational, thus a household will choose an outcome that maximizes utility (Train, 2009; Cameron and Trivedi, 2005; Deaton, 1997). The household *n* will choose to use *j* waste disposal option only if the perceived benefit from option *j* is greater than the utility from other options (say, i) depicted as: $Unj > Uni, \forall j \neq i \quad (2)$

The observed waste disposal choice y_n of a household n is defined as a vector of $Y_n = [Y_{nj}]$ of five dummy variables taking a value of 1 if the households choice falls on the j_{th} alternative and value of 0 otherwise. The probability that a household n chooses alternative j is specified as:

$$p_{nj} = p\left(y_n = \frac{j}{x_n}\right) = \frac{e^{\beta' j x_n}}{\sum_{i=0}^{j} e^{\beta' i x_n}}, \ \ j = 0,1,2,3,4 \quad (3)$$

In multinomial logit, it is impossible to identify parameter vectors β_0 to β_4 simultaneously. Hence, the parameters relating to a given category are usually set to zero, known as the reference category. The reference category chosen in this study is government/paid agency, that is, to say category 0. Consequently, vector β_0 is normalized to zero. Hence, the above model can be written as:

$$p_{nj} = p(y_n = j/x_n) = \frac{e^{\beta'_j x_n}}{1+\sum_{i=1}^{j} e^{\beta'_i x_n}}, \ j = 1,2,3,4. \ (4)$$

In multinomial logit model, the ratio of the probabilities known as the odds ratio (P_{nj}/P_{ni}) depends log-linearly on x_n written as:

$$\log\left(\frac{P_{nj}}{P_{ni}}\right) = x'_n(\beta_j - \beta_i) \quad (5)$$

Hence, the multinomial logit models are estimated by a maximum likelihood method. The explanatory variables included in the multinomial logit model used to analyse the determinants of households' choice of waste disposal methods in the study area were: X_1 = Age (Years), X_2 = Sex (1 if male, 0 otherwise), X_3 = Education (Years of schooling), X_4 = Marital status (1 if married, 0 if otherwise), X_5 = Household size (No of people), X_6 = Monthly income (Naira), X_7 = Major occupation (1 if farming, 0 otherwise) X_8 = Distance (Km).

Results and Discussion

Socio-economic Characteristics of Respondents in the Study Area

Result in Table 1 reveals that majority (63.3%) of the respondents were male. The mean age of the respondents was 36 years with respondents in the age range of 31-50 years constituting 42.5% of the total respondents. About 39% of the respondents had primary education, 66.7% were married with a mean household size of 5 persons. The study also reveals that 42.5% of the respondents were full time farmers, others were part time farmers who engaged in other occupation such as artisan (27.5%), trading (15.8%) and paid employment (14.2%) with a mean monthly income of ₦44,450. About 56% of the respondents travelled a distance of 1 to 2 km to the central dump site in the study area. The mean distance travelled was 1.29km.

Households' Choice of Solid Waste Disposal Methods in the Study Area

Table 2 presents the result on the households' choice of solid waste disposal methods in the study area. The result reveals that Burning (32.5%) was the prominent method of waste disposal used by the respondents in the study area. This result agrees with the findings of Babayemi & Dauda (2009) that several Nigerians have considered burning a cheap way of disposing off their solid wastes by setting the mixed wastes on fire in a little corner in their backyard or in a very open place causing serious and dangerous environmental pollution. Oyelola, Babatunde, & Odunlade (2009) reported that several cases of diseases have been recorded due to contact with smokes from burning of solid wastes and gaseous emission from dumpsites.

Open dump was the choice of 28.8% of the respondents in the study area. This result corroborates the findings of Ojo (2014) that majority of the respondents in Obantoko area of Abeokuta, Ogun State, dump their refuse in open dumps. Momodu, Dimuna, & Dimuna (2011) observed that improperly sited open dumps deface several cities, thereby endangering public health by encouraging the spread of odours, diseases, and pollution of water sources. Also, 12.0% of the respondents choose burying as their solid waste disposal method in the study area. Balogun, et al., (2017) reported that majority of poultry farmers in Ikenne LGA of Ogun State employed burying of wastes as disposal method mainly because of the offensive smell and sight of poultry waste which often become breeding

Table 1: Socio-economic Characteristics of Respondents in the Study Area *(N = 240)*

Variable	Frequency	Percentage (%)	Mean
Sex			
Female	88	36.7	
Male	152	63.3	
Age			
<30	96	40.0	36.08 (±10.253)
31-50	102	42.5	
>50	42	17.5	
Educational Qualification			
No Formal Education	19	7.9	
Primary Education	93	38.8	
Secondary Education	60	25	
Adult/Voc. Education	43	17.9	
Tertiary Education	25	10.4	
Marital Status			
Single	80	33.3	
Married	160	66.7	
Household Size			
1-5	180	75.0	5(±1.597)
6-10	60	25.0	
Other Occupation			
Farming only	102	42.5	
Self-employed	66	27.5	
Trading	38	15.8	
Paid employment	34	14.2	
Monthly Income			
≤40,000	150	62.5	44,450(±2728.23)
41,000-60,000	54	22.5	
>60,000	36	15.0	
Distance			
<1km	100	41.7	1.29(±0.134)
1-2km	134	55.8	
>2km	6	2.5	

Source: Field Survey Data, 2019

ground for a variety of pests, rodents and also generate polluted run-off into water ways and the environment. Landfill was the choice of 10% of the respondents while 16.7% paid government agencies or other waste managers to dispose their wastes. The implication of this result is that majority of the respondents dumped their solid wastes in unauthorized sites which could have negative consequences on the health of the people as well as sustainability of the environment.

Table 2: Distribution of Households by Choice of Solid Waste Disposal Methods

Waste Disposal Method	Frequency	Percentage
Landfill	24	10.0
Burning	78	32.5
Burying	29	12.0
Open dump	69	28.8
Government/private agencies	40	16.7

Source: Field Survey Data, 2019

Determinants of Households' Choice of Solid Waste Disposal Methods in the Study Area

The result of the multinomial logit model used to determine the socio-economic factors influencing the rural households' choice of solid waste disposal methods in the study area is presented in Tables 3. The p-value of the chi square test statistic for the overall significance of the model is 0.000, indicating that the multinomial logit regression is highly significant overall. The likelihood ratio test is highly significant (p-value=0.01), further indicating that a multinomial logit specification fits the data well. The multinomial logit results of the five waste disposal methods are presented in the following order, landfill, burning, burying and open dump. The reference category is paid private/government agencies.

Landfill method

The result in Table 3 shows that the determinants of landfill as a method of solid waste disposal in the study area were age ($p<0.10$), education ($p<0.05$) and household size ($p<0.05$). Age and educational level of the household heads negatively influence the likelihood of using landfill as a method of waste disposal. Younger household heads with low education were more likely to dispose their solid waste using landfill method and vice versa compared to using government agencies in the study area. Household size however, had a positive significant relationship with landfill method. This implies that the probability of households using landfill method increases with household size in the study area. Households with larger number of people would likely use landfill method of waste disposal rather than paid private/government agencies**.**

Burning method

The choice of burning as a solid waste disposal method was positively influenced by age ($p<0.05$), sex ($p<0.10$), marital status ($p<0.05$) education ($p<0.05$) of the respondents while it was negatively influenced by their major occupation ($p<0.05$). This result implies that household heads being male, older, married with higher level of education have higher probability of disposing their solid wastes by burning rather than employing the services of paid agencies. The result on education agrees with Foday, Xiangbin, & Quangyen (2013) who reported in similar study that, those who keep wastes in bins or burn them are most likely those with higher education. The negative influence of major occupation implies that burning method was mostly employed by household heads who are engaged in other occupation than farming.

Burying method

The socio-economic factors influencing the choice of burying as a method of solid waste disposal in the study area were age ($p<0.10$), marital status ($p<0.10$), education ($p<0.05$) of the respondents and the distance ($p<0.10$) to the centralised dump site The negative influence of age and marital status of the respondents imply that household heads being young and single increase the likelihood of choosing burying method more than their older and married counterparts. Burying involves the use of force and energy which might be too strenuous for the older respondents. However, education of the respondents and distance to dumpsites increases the likelihood of choosing burying method. These imply that educated household heads who lives at a far distance to the centralized dumpsite chose burying as their waste disposal method against government agencies in the study area.

Table 3: Determinants of Household's Choice of Solid Waste Disposal Methods

Parameter	Landfill	Burning	Burying	Open dump
Age	-0.141*	0.183**	-0.161*	0.153*
	(-1.89)	(2.32)	(1.83)	(1.91)
Sex	1.22	1.614*	-1.489	-1.260
	(1.28)	(-1.83)	(-1.42)	(-1.41)
Marital Status	1.423	2.402**	-1.786*	-1.397
	(1.49)	(2.59)	(-1.87)	(-1.54)
Education	-0.925**	0.707**	1.201**	-1.262***
	(-2.15)	(2.28)	(2.42)	(-3.04)
Household Size	0.670**	-0.384	-0.532	-0.538*
	(2.05)	(-1.27)	(-1.48)	(-1.72)
Monthly Income	0.000	-0.000	-0.000	0.000
	(0.40)	(0.38)	(-0.20)	(-0.76)
Occupation	-0.621	-0.701**	0.710	0.581
	(-1.30)	(-2.23)	(1.40)	(1.27)
Distance	1.100	-0.941	0.001*	-0.461
	(1.40)	(-1.28)	(1.76)	(-0.62)
Constant	5.602**	-1.225***	-2.950*	-2.468*
	(2.19)	(-3.925)	(-1.89)	(-1.87)

Notes: N= 239; Log likelihood value= -176.737; LR chi^2 (72) = 41.22; Prob. > chi^2 = 0.0000 Pseudo R^2 value = 0.5731
*** and ** indicate significance at 1% and 5% levels respectively.
Figures in parentheses are z-values

Open dump method

The probability of choosing open dumps compared to government agencies, increases with age ($p<0.10$) and decreases with education ($p<0.01$) and household size ($p<0.10$) of the respondents. The positive influence of age and the negative influence of both education and household size of the respondents on open dump method suggest that the likelihood of choosing open dumps increases with older household heads with lower education and small household size in the study area.

Households Suggestion on Waste Disposal in the Study area

Figure 1 presents results on the suggestions of the respondents on sustainable waste disposal methods in the study area. A larger proportion (36.67%) of the respondents suggested that there should be enough awareness programs through town hall meetings, seminars, workshops for the residence of the study area. Use of media/social media such as radio, television, SMS, WhatsApp messages, Facebook, etc. was suggested by 35% of the respondents while 28.33% suggested encouragement of environmental sanitation participation in the study area.

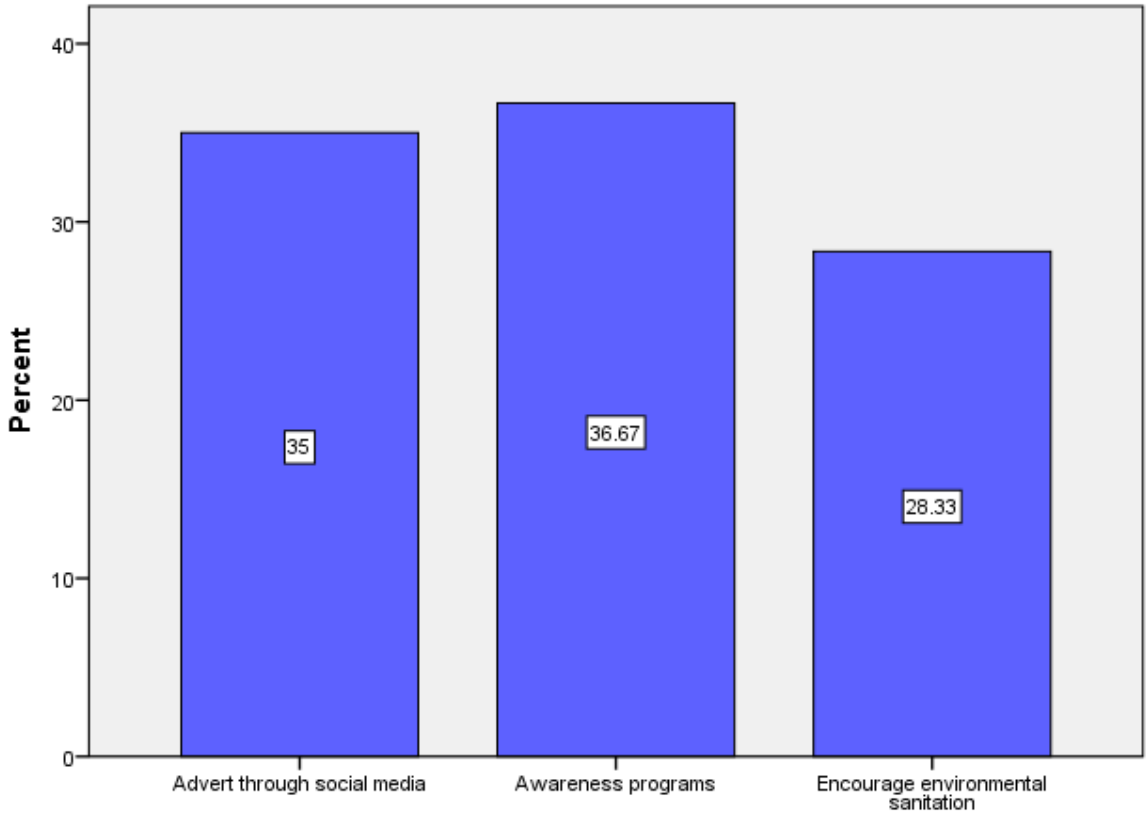

Fig. 1:Households suggestion on improved waste disposal in the study area

Conclusion and Recommendations

The study examined the pattern and determinants of rural households' choice of solid waste disposal methods in Ogun State, Nigeria, using descriptive statistics and multinomial logit model. Results revealed that majority (63.3%) of the respondents were male, 42.55 were within the age range of 31 to 50 years with a mean age of 36 years. Also, 42.5% of the respondents were full time farmers while others were part time farmers who engaged in other occupation such as artisan (27.5%), trading (15.8%) and paid employment (14.2%). It further revealed that burning (32.5%), open dumps (28.8%), government/private agency (16.7%), burying (12%) and landfill (10%) were the rural households' choice of solid waste disposal methods in the study area. This shows clearly that solid wastes were indiscriminately and unwholesomely disposed in the study area. This could negatively impact the health of the people, health of the ecosystems and sustainability of the environment. The multinomial logit regression model results revealed that household head's age, sex, marital status, education, household size, occupation and distance to centralized dumb sites were the determinants of rural households' choice of solid waste disposal methods in the study area. The respondents however suggested that public awareness programs (38.7%), sensitization via social media (35%) and participation in monthly environmental sanitation (28.3%) should be encouraged for the achievement of healthy and sustainable waste management in the study area.

To this end, the study recommends that rural households should be properly educated on the dangers of improper solid waste disposal methods on their health and sustainability of the environment, and by ensuring that every household is served by either private or government waste management agency. Healthy and sustainable methods of waste disposal like

sorting, recycling, incineration and composting should be encouraged while the old and unhealthy methods like open dumps, landfill, burying and burning which are predominant in the study area should be completely phased out. Recycling and reuse of these waste products will serve as source of revenue for government and employment for people. Furthermore, law enforcement agencies should be empowered to enforce participation in the mandatory monthly environmental sanitation program of the state. Community leaders, and landlords should also encourage better sanitation practices by formulating community by-laws that prohibits indiscriminate waste dumping. Defaulters of such laws should be appropriately sanctioned and fined to serve as deterrent to others

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