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Cultural and Perception Dimensions of Faecal Waste Applications for Sustainable Reuse in Ogun State, Nigeria

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The generationof biogas from faecal wastes currently offers limited economic and environmental benefits to low-income households. The production of biochar from faecal waste is a sustainable alternative to firewood to replace charcoal that is widely utilised for cooking in households in Nigeria. Similarly, biochar production from faecal wastes presents a clean and renewable alternative approachfor creating value from faecal waste. Furthermore, this presents cost-effective recovery, containment, and management of faecal waste. Therefore, the objective of this study is to investigate the existing faecal waste management practices by households in Ogun State, Nigeria. It will also examine perceptions of households to faecal waste as a valuable resource, in either its raw or processed form for energy applications. Based on the multi-stage sampling approach, a total of 165 questionnaires were administered to representative households in the study area. Consequently, a total of 55, 50, and 60 questionnaires were administered in Surulere, Ilaro I, and Sodeke/Sale-Ijeun I, in the ratio 1.1:1.0:1.23.The selected criteria reflect the variance in the populations of 1,250,435 (33 %), 1,112,761 (30 %), and 1,387,944 (37 %) for Ogun East, Ogun West, and Ogun Central.The study revealed that the most important reason for the prevalence of unsustainable non-recovery faecal waste management in the study area is the perception that households could be exposed to danger as recovered sludge could be used for fetish purpose. Furthermore, at p=0.00, knowledge of faecal waste reuse expressed by respondents strongly associated with their choice of faecal waste emptying method. Lastly, adequate awareness of good sanitation practices and the economic gains of recovering and reusing faecal waste in households requires sustainable enforcement in Nigeria.

1. Introduction

Rose et al. (2015) estimate the average daily quantity of excreta produced by adult humans to be about 130 g of faeces and 1.4 L of urine per capita. Proper containment and management of faecal waste are essential in the prevention of waterborne diseases and water pollution (Harada et al., 2016). As captured in WHO/UNICEF JMP (2017), there are 2.3 B people worldwide who still need basic sanitation. These are further categorized into three groups; those who defecate in the open spaces (892 M), those who use shared sanitary facilities such as a pit or bucket latrines sometimes without coverings (856 M); and the remaining (600 M) who use improved sanitation facilities that are shared with other households. Sanitation situation is particularly worrisome in Nigeria and most developing countries in Africa and South Asia (WHO/UNICEF 2015). According to WaterAid Nigeria (2016), the number of people who openly defecate in Nigeria's land mass of 923,770 km^2 is about 46 M. This puts the country's open defecation rate to be at50 people per km^2, and presents the country as the 6th worst nation in the global open defecation challenge . Similarly, the 2016/2017 Multiple Indicator Cluster Survey conducted by the UNICEF across Nigeria revealed that open defecation is still being practised in 771 out of 774 Local Government Areas in Nigeria, with 25% of the national population still defecating openly (Vanguard Newspaper, 2018). This sanitation profile, however, has both economic and health consequences (Water Aid ,2015). As contained in World Bank (2012), persons practising open defecation use an average of 2.5 d/y

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searching for private spaces to defecate, culminating in huge economic losses and health challenges. The global economy had incurred about 222.9 USD billion in 2015, up from 182.5 USD billion in 2010, owing to the dearth of access to sanitation. This is a rise of over 40BUSD in just five years, with countries like Nigeria losing 3B USD to bad sanitation, representing about 1.3% of her GDP (WaterAid, 2016). Moreover, poor sanitation contributes chiefly to neglected tropical diseases like Schistosomiasis, trachoma and intestinal worms, which affect over 1.5 B people every year (WHO, 2015).Diarrheal related deaths in Nigeria reached 130,610 and 6.85% of total deaths (WHO, 2017). Also, 60,000 children under the age of five in Nigeria die from diarrheal diseases principally occasioned by terrible levels of access to water, sanitation and hygiene (Thisday, 2017). The poor human development index in Nigeria, typified by the high infant mortality rate (72.7 per 1000 live births) and under five mortality (72.7 per 1000 live births) is directly linked with sanitation indices (Aluko et al., 2017) .The major constraints to the construction of improved sanitation facilities that can obviate open defecation in developing economies are lack of money and topography (Wateraid 2013). Others are insufficient space and lack of information on the reuse benefits of faecal waste (Tsinda et al., 2013).

However, several strategies have been recommended on how households can be encouraged to construct and manage improved toilets, and consequently eradicate open defecation. Rao et al.(2017) opined that resource recovery and reuse offers vista as incentives for a more viable investment in the sanitation service chain, which can equally motivate investment in the construction of toilets by households. This apparently contrasts with the direct monetary subsidies variant of incentive being canvassed in Bansal (2017), which has applications in countries like India. The incentive option of creating values for faecal resource and allowing it to cover the cost of construction and maintenance of containment facilities, over time, is imperative in developing economies, as they mostly face the problem of budget and capacity constraints in implementing the option of direct subsidies (Mittal et al.,2017).

The 9.5 Mm^3 of human excreta and 900 m^3 of municipal wastewater generated on a daily basis globally can adequately afford enough nutrients to substitute for the 25% of the synthetic nitrogen currently being used to fertilise farmlands in the form of inorganic fertilisers(Andersson et al., 2016). Until recently that the reuse outlook of faecal waste is gaining more traction in developing countries, the important motivation for the agricultural application of excreta is the easy disposal it affords rather than the planned need for nutrients recovery and possible commercialisation(Jiménez et al., 2010). According to Olufunke et al. (2016), more farmers now consider faecal wastes as alternatives to chemical fertilisers. Danso et al. (2017)were instructive on the reuse potentials of faecal wastes in the production of fodder or feeds for livestock in aquaculture.

Further, high energy char, which can be used domestically for cleaner cooking, can be produced when faecal waste is subjected to microwave hydrothermal carbonisation (M-HTC) treatment, which is a microwave assisted thermochemical conversion process between 180 °C and 200°C (Afolabi and Sohail, 2017). This represents a green alternative to firewood and charcoal and its adoption can help mitigate their associated environmental impacts on deforestation and environmental contamination (Afolabi et al., 2017). Solid biofuels, a renewable resource, which produces less greenhouse gas emissions, can also be produced from faecal waste (Mohson et al., 2017). The inorganic content in sewage sludge had also been found beneficial for the production of construction materials. According to Semiyaga et al.(2015), the incinerator ash, produced from the incineration of sewage sludge disposal, when mixed with dried sludge can be used as additives in the production of construction materials such as artificial lightweight aggregates, tiles, cement material and bricks. However, the practicality of faecal waste reuse is not just premised on the costs of the installation, operational and maintenance technologies in waste processes but also social acceptability and economic affordability factors. Despite the significance of the foregoing, knowledge gaps about the economic, cultural and perceptional constraints of the reuse component of faecal waste management by households exists.

For instance, most households would rather bury latrines or shrink faeces with acid, due to the belief the method is cheaper. Others consider emptying faecal waste exposes them to fetish diabolic tendencies which hamper the recoverability and the application of faecal waste for reuse. The socio-economic role increased awareness in reuse possibilities can play in the creation of new values for faecal waste is equally unclear in literature. The emphasis on households as the unit of study is quite important, as households, where stereotypes and perceptions are held, are the potential generators of the faecal resource. Also, the potential human users of recycled or reusable products of faecal waste in farms, aquaculture industry, construction sites, and domestic kitchens equally emanate from households.

This study is aimed at investigating the cultural, economic and perceptional issues that can influence household faecal resource's recoverability and reusability in Ogun State, Nigeria. The objectives of the study are to investigate households' faecal waste emptying methods and perceptions about their choices, and determine the relationship between households' awareness of faecal waste reusability and their choice of faecal waste emptying method. The study shows that the most important reason for the prevalence of unsustainable non-recovery faecal waste management in the study area isthe perception that households could be exposed to

danger as recovered sludge could be used for fetish purpose. Furthermore, at p=0.00, knowledge of faecal waste reuse expressed by respondents strongly associated with their choice of faecal waste emptying method.

2. Methodology

The study adopts the multi-stage approach in the classification of Ogun state into its three main senatorial districts: Ogun East Senatorial District, Ogun West Senatorial District, and Ogun Central Senatorial District. The second stage involves the random selection of Sagamu, Yewa South, and Abeokuta South Local Governments as the sampling Local Governments in Ogun East Senatorial District, Ogun West Senatorial District, and Ogun Central Senatorial District. The third stage involves the random selection of representative wards, namely, Surulere, Ilaro Iand Sodeke/Sale-Ijeun I, from each of the sampling Local governments. Atotal of 165 questionnaires were administered to representative households in the study area. This implies that 55, 50, and 60 questionnaires were administered in Surulere, Ilaro Iand Sodeke/Sale-Ijeun Ion the 1.1:1.0:1.23 ratio reflecting the variance in the population of 1,250,435 (33 %), 1,112,761 (30 %), and 1,387,944 (37 %) for Ogun East, Ogun West and Ogun Central. The multi-stage method of sampling adopted, which several random processes enable eventual selection of suitable samples within homogenous clusters, immensely reduced the chance of sampling error that could be associated with the sample percentage. The descriptive method was employed in presenting socio-economic information of respondents and aspects of their sanitary profile. However, Chi-square was used to assess the association betweenawareness of reuse of faecal waste and respondents' educational level and the association between method of waste management adopted by respondents and awareness of reuse.

3. Main results

3.1 Socio-economic characteristics of survey respondents

The study reveals that the males account for the majority of respondents (64.2 %) and the population areessentiallyofYoruba ethnicity. The age of respondents ranged from 27 to 78 y with a median age of 52 y and a standard deviation of 12.8. Also, 79.5 % of respondents had a minimum of secondary education. A high percentage of 97.4 % were employed either as artisans, civil servants and private sector employees, while the rest are unemployed. Majority of respondents (45.9 %) were ranked as belonging to the Lower-Middle Class. This is followed by others who were ranked in the Upper-Medium Class (26.1 %), Floating Class (12.1 %) and the Rich (4.8%). This grouping, however, was guided by the World Bank classifications of economic classes on the basis of per capita consumption levels in Africa , which are <61 USD/mth, < 124 USD/mth, < 310 USD/mth , < 620 USD/mth and > 620 USD/mth for the Poor, Lower-Middle Class, Upper Middle Class, and the Rich(Corral Rodas et al., 2017).

3.2 Households methods of faecal waste containment, emptying, and their perceptions

The major types of faecal waste containment facilities in the study area are pit latrines (54.5 %) and septic tanks (40.5 %). Hence, the prevailing methods for faecal waste emptying in the study area were classified into three groups. Emptying with the aid of manual emptiers (20.1 %); emptying with mechanical emptiers (31.5 %); and the non-recovery management (NRM) method (48.4 %). The NRM is the dominant variant which involves burying of filled latrines with sand or digging new pits within the same compound, and the use of acids to shrink sludge. The study further reveals that 90% of the respondents believed that non-recovery faecal waste management method affords a neater option, unlike the other two options that are associated with stench, flies, diseases, and indiscriminate dumping. Similarly, all the respondents believed the non-recovery management option was cheaper at a mean value of 22.82 USD compared to the mean charges of 48.40 USD and 73.71 USD for manual and mechanical emptying methods. The tendency for the majority to recourse to the cheaper option can be appreciated within the context of the fact that the majority of respondents fall below the lower-middle class. This category, which is more impacted by the rising cost of food have less to dispose of sanitation management. It is also curious that 90.5% of respondents cited the fact that people use sludge for fetish purpose as the reason they would not allow evacuation of the sludge from their latrines but will prefer burying the filled pit and digging another or shrinking the sludge with acids. This cultural perception is the most delicate a nd sensitive threat to recoverability and reuse of waste in the study area. However, some respondents (9.5%) had knowledge either of the options of burying several pits within the same compound or the use of acids to shrink sludge in buildings life cycles can pollute underground water.

3.3 Households awareness of the faecal waste reuse applications options

An investigation by the study on the level of respondents' awareness of key options of faecal waste reuse relied on a scale of six variables, which was considered reliable at Cronbach's alpha coefficient value of 0.71. As

presented in Table 1, while 89.1 % of respondents believed that faecal wastes have applications in farmlands as manures, 60 % deemed this useful as feedstock for fishes. Moreover, over half of the respondents (60 %) were certain of faecal wastes' utility in the production of biogas. However, about 32.7 % of the respondents know that faecal wastes can be converted to char, which can replace charcoal and firewood for cooking. Worse, only 5 % are aware faecal waste can be used as additives in the production of construction materials. The level of awareness of faecal waste reuse is actually high in respect of traditional applications in farms and aquaculture. Awareness of reusability of faecal waste in other applications such as the production of biogas, char production, and additives in the production of construction materials like bricks and tiles is still very low. This is due to the gap in local technology for recycling faecal waste to the products and the inadequacy of research to help trickle down knowledge.

3.4 Relationship between awareness of reuse and associated variables

The knowledge of reuse by household scale, which had been added up and averaged using the Transform tool of the SPSS, and the level of respondents' education, and how respondents' latrines were emptied represent the variables for this research. However, at 0.00 significant levels each, for both Kolmogorov-Smirnov and Shapiro-Wilk tests, the data failed the normality test. Non-significant results of more than 0.05 would have indicated normality. This, therefore, makes the adoption of non-parametric Chi-squared test to assess the relationship between the variables expedient. Table 2 shows that significant association was found between the awareness of faecal reuse applications expressed by households and the level of their education (p =0.00).

Table 1: Households' knowledge of the options for faecal waste reuse

Description of Variables	Agree (%)	Undecided (%)	Disagree (%)
Faecal waste can be used in farmlands as manures	89.10	7.90	3.00
Faecal waste can be used as feedstock for fishes	60.00	37.60	2.40
Faecal waste can be converted to char for cooking	32.70	52.70	14.50
Faecal waste can be used to produce biogas	60.00	25.50	14.50
Faecal waste can be used as construction additives	5.00	23.00	72.00
Faecal waste has no reuse value	2.40	5.50	92.20

Table 2: Chi-Square tests of relationships between variables

Chi-Square Test	Values	Df	Asymp.Sig (2-sided)
Pearson Chi-Square 1	2.174	40	0.00
Pearson Chi-Square 2	1.298	27	0.00

Furthermore, at p = 0.00, awareness of faecal waste reuse expressed by respondents are strongly associated with their choice of faecal waste emptying method. The first relationship implies that people with higher education are probably more aware of the reuse of faecal waste. The educated category stands a greater chance of coming across research outcomes or news about new applications of faecal waste in journals, textbooks, newspapers, and on television and radio. The second assessment implies that those who are aware of the diverse reuse options for faecal waste are more likely to adopt faecal waste emptying methods that afford recoverability and eventual reuse. This is in line with Appiah-Effah et al. (2013) that enlightenment and awareness creation is essential not just in addressing the bad sanitary conditions, but also the adoption of the best faecal waste management practice. However, there are also other factors such as the cost of construction, level of income, access to buildings by faecal waste emptying tankers, and others, which can influence the type of faecal waste emptying methods adoptable by households.

4. Conclusions

The study is an insight into the social, cultural, and economic issues that can represent constraints to faecal resource's recoverability and adoption for reuse. It has revealed the socio-economic characteristics of households and shown households' propensities and perceptions in respect of specific faecal waste emptying methods. Moreover, the relationship between households' awareness of faecal waste reusability, their level of education and their choice of faecal waste emptying method has been established. From the study, it is evident that with the prevailing non-recovery faecal waste emptying method (48.4 %), coupled with the limited knowledge of reuse applications, especially in areas different from the traditional spheres of agriculture, the quest to leverage on inherent reuse value of faecal resource as an incentive to encourage households to construct toilets, and consequently improve sanitation and stimulate business opportunities, is stymied.The

study, however, suggests that government agencies in charge of faecal waste management develop proactive action plans such as enlightenment campaigns aimed at sensitizing households not just on the health benefits of constructing toilets, using them, and adopting sustainable management practices, but also on the revenues faecal resource reuse can generate to help offset the cost of constructing and maintaining sanitary containment facilities by households. There is also the need for proactiveness on the part of the planning and environmental agencies that have jurisdiction over development control and environmental management in the study area.The study recommends that physical planning agencies should intensify the monitoring of development activities to ensure toilets,especially the ecologically friendly variants that afford resource recovery, are constructed in new buildings. The idea of enforcing households to properly empty and disposeof their faecal waste may no longer be fashionable if the strategy of creating value for faecal waste can be fully embraced. However, it is still essential that access roads are provided in neighbourhoods where faecal wastes' emptying tanker's mobility may be hampered by lack of access. Further,there is also the need for investment in the emptying component of the faecal waste management value chain to be supported fully as a private sector led business . This will definitely spin-off economic opportunities in the study area, and represent a win-win for economic growth and environmental sustainability. Finally, there is a need for the adoption of simple onsite low-cost technologies, which can allow for neat emptying and equally produce high-value faecal waste-derived products as a way of motivating households to properly manage their faecal waste, and equally stimulate business opportunities.

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