

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

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The generation of 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 approach for 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 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, respectively, 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, respectively. The study revealed the prevalence of unsustainable non-recovery faecal waste management in the study area. Furthermore, at $p=0.00$, knowledge of faecal waste reuses expressed by respondents strongly associated with their choice of faecal waste emptying method. Lastly, adequate awareness on 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) estimates 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 is 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 billion people worldwide who still need basic sanitation. These are further categorized into three groups; those who defecate in open space (892 million), those who use shared sanitary facilities such as pit or bucket latrines sometimes without coverings (856 million); and the remaining (600 million) who use improved sanitation facilities that are shared with other households. The situation is particularly worrisome in Nigeria and most developing countries in Africa and South Asia. According to WaterAid (2016), with its number of people who openly defecate at about 46 million in its land mass of 923,770 km², Nigeria's open defecation rate is therefore 50 people per km². This puts the country as the 6th worst nation globally for open defecation. Similarly, the 2016/2017 Multiple Indicator Cluster Survey conducted by the UNICEF across Nigeria revealed that open defecation is still being practiced 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. As contained in World Bank (2012), persons practicing open defecation use an average of 2.5 days a year searching for private spaces to defecate, culminating in huge economic losses and health challenges. The global economy had incurred about US\$222.9 billion in 2015, up from US\$182.5 billion in 2010, owing to dearth of access to sanitation. This is a rise of over US\$40 billion in just five years, with countries like Nigeria losing \$3 billion dollars 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 billion 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 major constraints to the construction of improved sanitation facilities that can obviate open defecation in developing economies are lack of money, topography, 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 million m³ of human excreta and 900m³ 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 are 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. Solid biofuels, a renewable resource, which produce 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 perceptual constraints of the reuse component of faecal waste management by households still exist.

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 hampers 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. Therefore, this study is aimed at investigating the cultural, economic and perceptual issues that can influence household faecal resource's recoverability and reusability in Ogun State, Nigeria.

1.1 Methodology

A total 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 I, and Sodeke/Sale-Ijeun I, respectively, on 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, respectively. 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 between awareness of reuse of faecal waste and respondents' educational level and the association between method of waste management adopted by respondents and awareness of reuse.

2. Main Results

2.1 Socio-economic characteristics of survey respondents

The study reveals that the males account for the majority of respondents (64.2%) and the population are essentially of Yoruba ethnicity. The age of respondents ranged from 27 to 78 years with a median age of 52 years 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 dollars per month, < \$124 per month, < \$310 per month, < \$ 620 per month, and > \$ 620 per month for the Poor, Lower-Middle Class, Upper Middle Class, and the Rich, respectively (Corral Rodas et al., 2017).

2.2 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 compared to the mean charges of \$48.40 and \$73.71 for manual and mechanical emptying methods, respectively. The tendency for the majority to recourse to the cheaper option can be appreciated within the context of the fact that majority of respondents fall below the lower-middle class. This category, which are more impacted by the rising cost of food have less to dispose on 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 and 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.

2.3 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 production of bio-gas, 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.

2.4 Relationship between awareness of reuse and associated variables

Enlightenment and awareness creation are essential not just in addressing the bad sanitary conditions, but also the adoption of best faecal waste management practice (Appiah-Effah et al., 2013). 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

	Value	Df	Asymp.Sig(2-sided)
Pearson Chi-Square 1		40	0.00
Pearson Chi-Square 2		27	0.00

Furthermore, at $p=0.00$, awareness of faecal waste reuse expressed by respondents is strongly associated with their choice of faecal waste emptying method. The first relationship implies that people with higher education are probably more aware about the reuse of faecal waste. The educated category stands 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 emptying methods that afford recoverability, and eventual reuse. This however does not imply they would rather still adopt such recovery affording emptying methods, as there are also the factors of cost, access to buildings by faecal waste emptying tankers that can influence the type of faecal waste adoptable by households.

3. 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. 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 planning and environmental agencies that have jurisdiction over development control and environmental management in the study area as canvassed in Oyesile and Olapeju(2013). While it is essential for development applications made to planning agencies to integrate adequate toilets before being considered approvable, monitoring of actual site development activities must be carried out to ensure toilets, especially the ecologically friendly variants that afford resource recovery, are constructed. The idea of enforcing households to properly empty and dispose their faecal waste may no longer be fashionable if the idea of creating value for faecal waste can be fully embraced. However, it is still essential that enablements, such as the provisioning of access roads in neighbourhoods where faecal wastes' emptying tanker's mobility may be hampered, are afforded. 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 setor led business. This will

definitely spin-off economic opportunities in the study area, and represent a win-win for economic growth and environmental sustainability. There is 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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