MULTI-SOLVING ACTION FOR METHANE REDUCTION IN NIGERIA (MAMRN)

BASELINE STUDY REPORT ON BENIN CITY, EDO STATE, EPE, LAGOS STATE, JOS TOWN, PLATEAU STATE AND FCT, ABUJA

APRIL 2025

ACRONYMS AND ABBREVIATIONS

AEPB –Abuja Environmental Protection Board
BSF – Black Soldier Fly
CAP– Climate Change Policy
CH_4 – Methane
CC – Climate change
C40 – C40 Cities Climate Leadership Group
CfEW – Centre for Earth Works
CFEW – Centre for Earth Works Development
CODAF – Community Development Advocacy Foundation
CO_2 – Carbon Dioxide
EPI – Environmental Performance Index
ESWMB – Edo state waste management Board
FAO – Food and Agriculture Organization
FCT – Federal Capital Territory
FGD – Focused Group Discussion
FESTAC –Festival of Arts and Culture
GAIA – Global Alliance for Incinerator Alternatives
GHG – Greenhouse Gas
GKF– Green Knowledge Foundation
GIS – Geographic Information System
IEA – International Energy Agency
IPPC – Intergovernmental Panel on Climate Change
LAWMA – Lagos State Waste Management Authority
LDC – Least Developed Country
LGA – Local Government Area
LMI – Low-middle income
LT-LEDS –Long-Term Low Emission Development Strategies (LT-LEDS)
MAMRN – Multi-solving Action for Methane Reduction in Nigeria
MRF – Material Recovery Facility
MSW – Municipal Solid Waste
$MtCO_2e$ –Million Tonnes of carbon dioxide equivalent
N_2O – Nitrous Oxide
NGHGIMS – National GHG Inventory Management System
NDCs – Nationally Determined Contributions
OFMSW – Organic Fraction of Municipal Solid Waste
PAVE – PAN African Vision for the Environment
PE– Polyethylene and
PET– Polyethylene terephthalate
PEPSA – Plateau Environmental Protection and Sanitation Agency
PSP – Private Sector Participants
SDG – Sustainable Development Goal
SSA – Sub-Sahara Africa
SEDI –Sustainable Environment Development Initiative
SRADev – Sustainable Research and Action for Environmental Development

TLS – Transfer loading stations
UNEP – United Nations Environment Programme
UNIDO – United Nations Industrial Development Organization
UNDP – United Nations Development Program
UN – United Nations
UN-DESA – United Nations Department of Economic and Social Affairs
UNFCCC – United Nations Framework Convention on Climate Change
WaP – Waste Parliament
ZeWA – Zero Waste Ambassadors

1. BACKGROUND OF PROJECT

1.1.Challenges of Solid Waste Management

Improper solid waste management practices remain a significant issue for most urban settlements in developing countries, especially in the Sub-Sahara Africa where the gap between waste generation and collection is wide, compared to situation in developed nations. Open dumpsite is an important source of environmental pollution and leading driver of global warming and climate change through emission of methane (CH_4) from decomposition of organic waste and carbon dioxide (CO_2) through open and uncontrolled burning of waste heaps in the guise of reducing waste volume. Carbon-dioxide and methane have been implicated in climate change, and their concentration levels in the atmosphere have increased since the industrial revolution. More importantly, municipal solid waste generation is linked to industrialization, urbanization, including income level, urban lifestyle and population. According to the World Population Clock (2025), the current world population is 8.2 billion People which is expected to grow to around 8.5 billion in 2030 and 9.7 billion in 2050 (UN-DESA, 2017). It is projected to reach a peak of around 10.4 billion people during the 2080s and to remain at that level until 2100 (UN, 2017). As of 2023, the total population of Africa was over 1.48 billion (Galal, 2024). In another report, Africa's population is expected to reach 1.7 billion by 2030, up around 400 million from 2024. This corresponds to an average yearly growth rate of approximately 2.3%, which is much higher than the global average (Igarta 2024). Most of this expansion is anticipated in Sub-Saharan Africa, where the population is estimated to double by 2050 (Igarta 2024). More than half of the world's population, about 4.4 billion people – lives in cities (World Bank Group, 2025). This trend is set to continue, with the urban population expected to more than double by 2050, at which point nearly 7 in 10 people will live in cities (World Bank Group, 2025).

1.2.Population and Municipal Solid Waste Generation

In Africa one of the major demographic trends projected by 2030 is a sustained shift toward urbanization. By 2030, more than half of Africa's population is expected to live in cities, up from approximately 43% in 2024. This trend is predicted to continue in the future decades, with urban populations forecast to reach 60% by 2050 (Igarta, 2024). The population and urbanisation trends in Nigeria are not different from global and regional trends. The total population in

Nigeria was estimated at 223.8 million people in 2023 (Trading Economics, 2025), 50% of which dwell in urban centres. Nigeria's population is expected to grow from the present population of 200 million to roughly 230 million by 2030 (Igarta, 2024). This makes Nigeria the world's third most populated country by 2050, behind India and China. Cities are engines of economic growth and development; hence an increased urban population, changes in living standards/lifestyles and consequently an increase in waste generation. Once a city is built, its physical form and land use patterns can be set for modifications, often leading to unsustainable urban sprawl and municipal solid waste (MSW) management. This also strains land and natural resources, with cities producing more waste than it can manage, especially in developing countries. According to a World Bank report, the world produces 2.01 billion metric tonnes (Mt) of municipal solid waste per year (World Bank, 2022a), with at least 33% not being managed in an environmentally sound manner (Kaza et al., 2018). Rapid urbanization, population growth and economic development are also expected to result in an increase in waste generation globally by 70% in the next 30 years, reaching by 2050, a startling 3.40 billion Mt of waste produced annually (World Bank, 2018). Studies further shows that the annual volume of waste generated in sub-Saharan Africa (SSA) increased from 81 million tonnes to 174 million tonnes per year between 2012 and 2016 and is projected to reach 269 million tonnes in 2030 (Adedara et al., 2023). In 2018, SSA's municipal solid waste (MSW) collection coverage was estimated at 44% (Adedara et al., 2023). Nigeria generates more than 32 million tons of solid waste annually, out of which only 20-30% is collected (Adedara et al., 2023). Consequently, the collection of MSW remains the most critical aspect of waste management (WM) in developing countries like Nigeria (Pires et al., 2019; Carlos-Alberola et al., 2021), and according to UN-HABITAT, (2010), this strains municipal budgets.

1.3. Challenges of MSW Management in Developing Countries

It is reported that while the MSW collection rate is estimated at 96% in high-income nations, most least-developed countries (LDC) have a collection rate of about 39%, with low-middle income (LMI) nations reaching about 51% (Kaza, et al., 2018). City dwellers in developing countries, especially the urban poor, are critically impacted by unsustainably and poorly managed municipal solid waste. In most developing countries such as Nigeria, over 90% of waste is often disposed in unregulated/undesignated open dumps, unused land/open space,

waterways or openly burned (World Bank Group, 2022a) (Plates 1-5). These practices create serious health, safety, and environmental consequences. More so, poorly managed waste serves as a breeding ground for disease vectors, contributes to global climate change through CH_4 generation through decomposing process, and CO_2 during burning. In most cities in Nigeria, this is a common practice, and a study found that waste-related GHG accounted for 5% of worldwide emissions (excluding transportation) in 2016 (World Bank, 2022b). Open dumpsites and unregulated dumpsites will increase GHGs emissions, leading to climate change. On the other hand, climate change will exacerbate the environmental and health risks associated with open dumpsites through increased storm water runoff and flooding of MSW dumps.

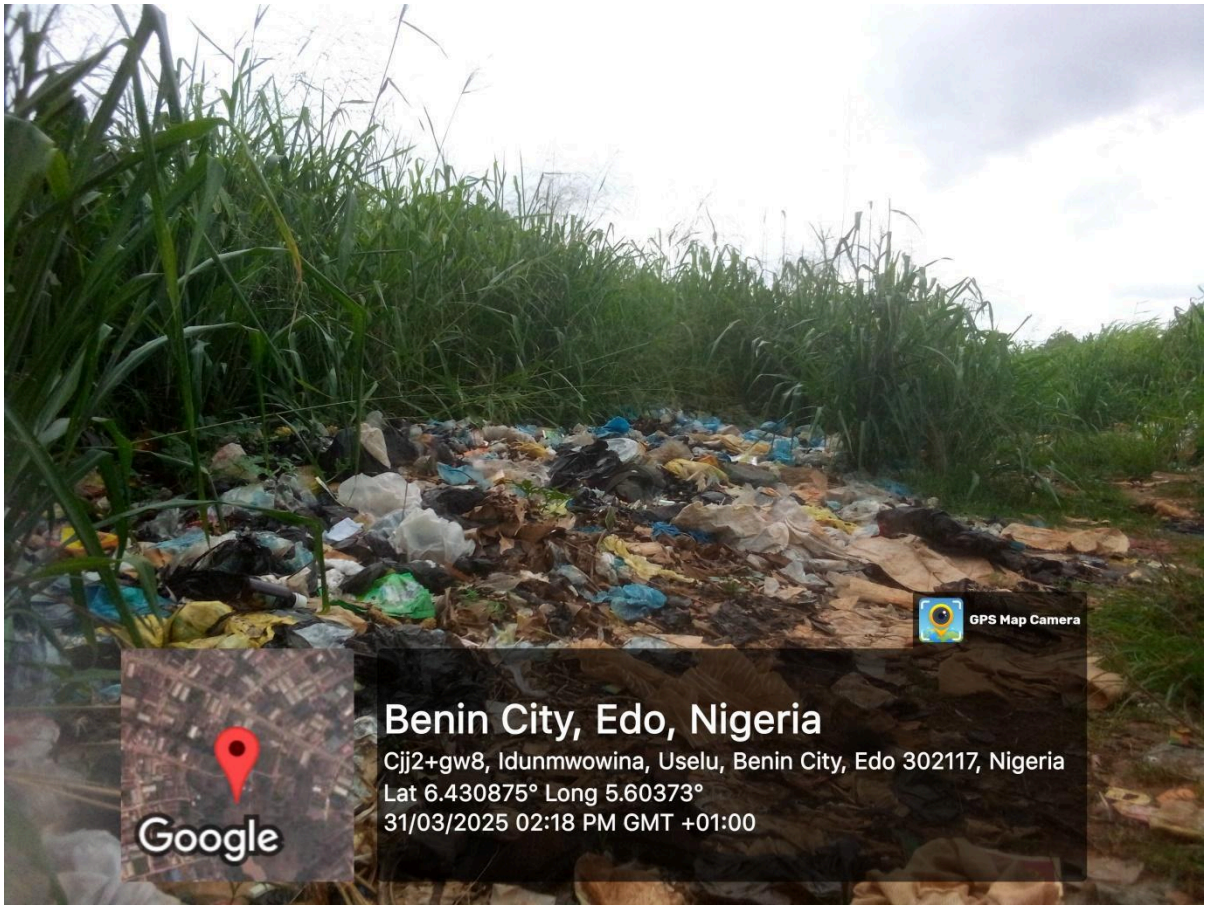


Plate 1: Open/illegal dumping of MSW on open space in Benin City Edo State

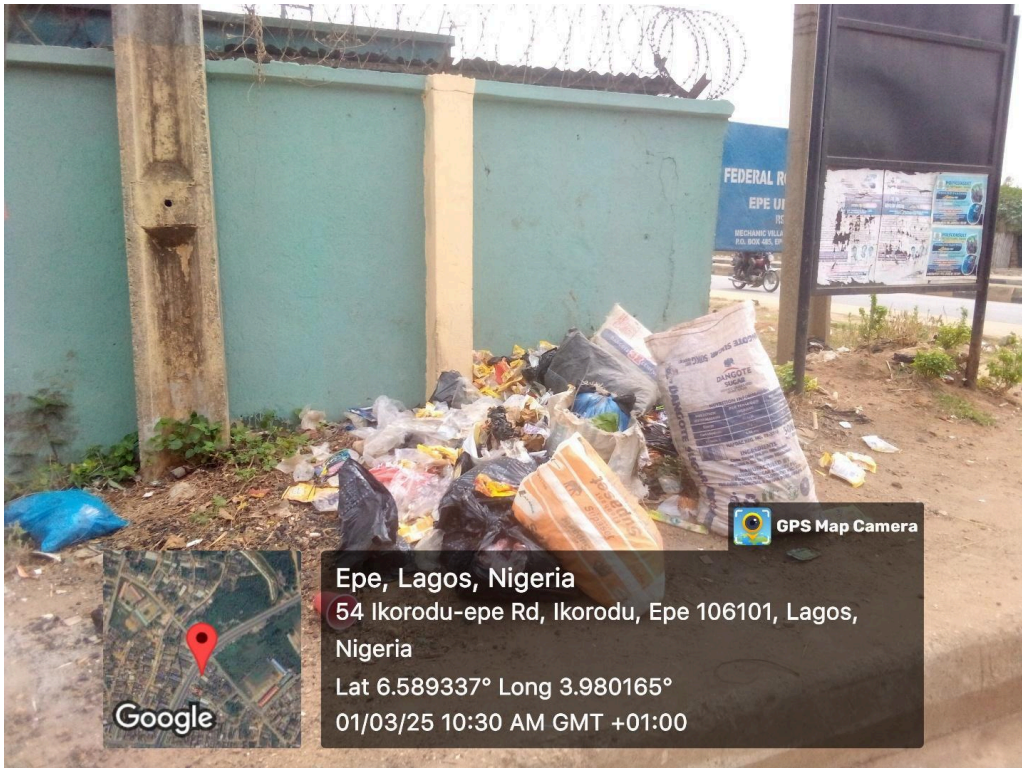


Plate 2: improper dumping of household refuse in open space in Epe town, Lagos State



Plate 3: Improper dumping of along Marina Road, Epe Lagos

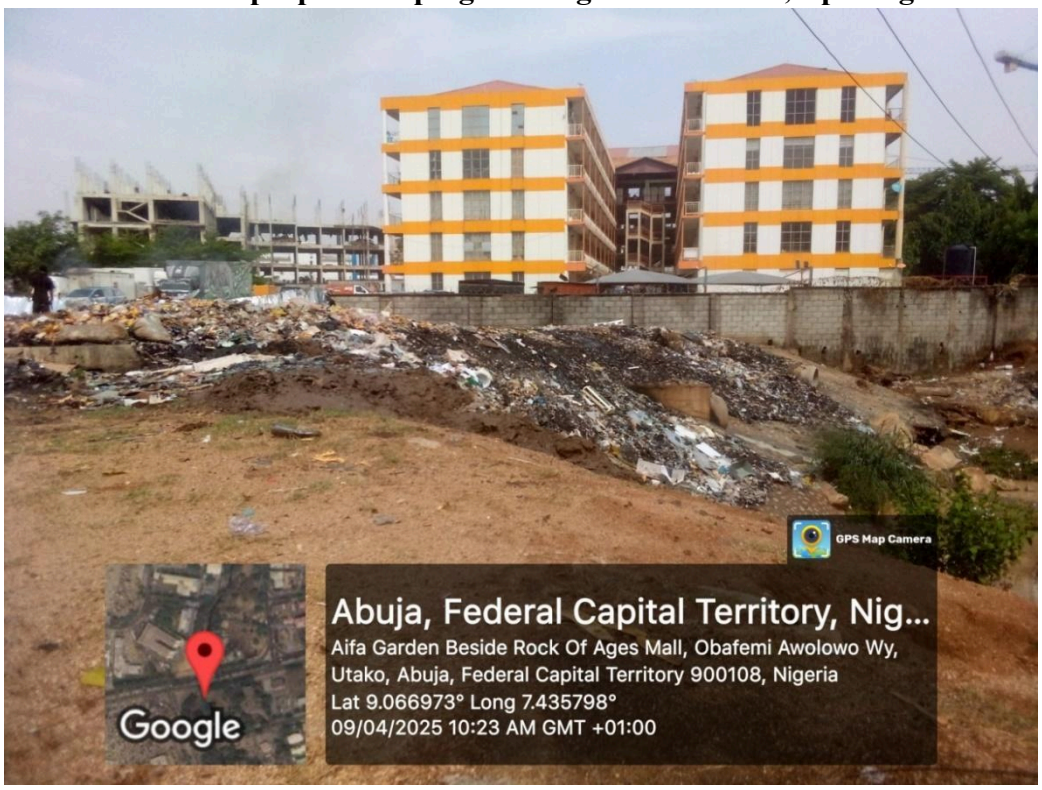


Plate .4: Open/illegal dumping of MSW on open space in FCT, Abuja, Nigeria

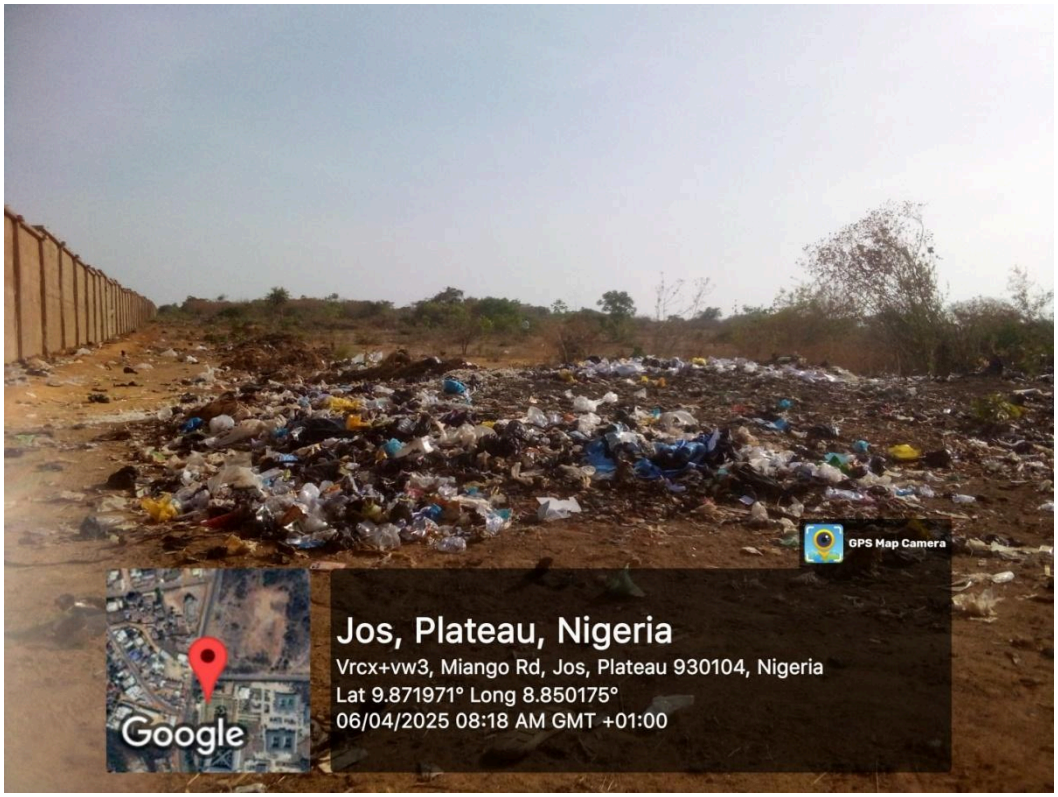


Fig.5: Open/illegal dumping of MSW on unused space/land in Jos City, Plateau State

1.4.Improper Solid waste management and Environment issues

There are evidences that Nigeria is already experiencing environmental challenges attributed to climate change (CC) and its impacts. These impacts range from rising temperatures, increased intensities and frequencies of droughts and flooding, coastal erosion, Health Risks and Disease Outbreaks, all of which are becoming a major obstacle to Nigeria's sustainable development. More specifically, climate change is exacerbating existing vulnerabilities, including food insecurity, water scarcity, and health disparities, and it is fuelling farmers-herder crisis in parts of the country. The rising sea levels and changing weather patterns threaten coastal communities and crucial agricultural sector, jeopardizing livelihoods and national economic stability. The country's susceptibility to climate change is heightened due to its geographical location and low adaptive capacity to climate change impacts; a condition which creates an urgent need for climate actions, and in particular initiatives aimed at zero methane and/or complete diversion of organic fraction of municipal solid waste (OFMSW) from waste stream and the use of same resources as materials for composting. The amount of methane produced by a landfill is primarily based on the amount of organics in the waste stream. Globally, organic waste makes up about 44% of waste generated, with food and green waste as the largest (Yatoo et al. 2024). In Nigeria, about 50% of the MSW fraction is organic such as the leftover of food waste, green waste (yard), wood waste, etc. Their abundance in waste streams maybe attributed to the low level of industrialization of agricultural production and processing in Nigeria. This is followed by plastic materials with polyethylene (PE) and Polyethylene terephthalate (PET) been most common (Plates 6-9).

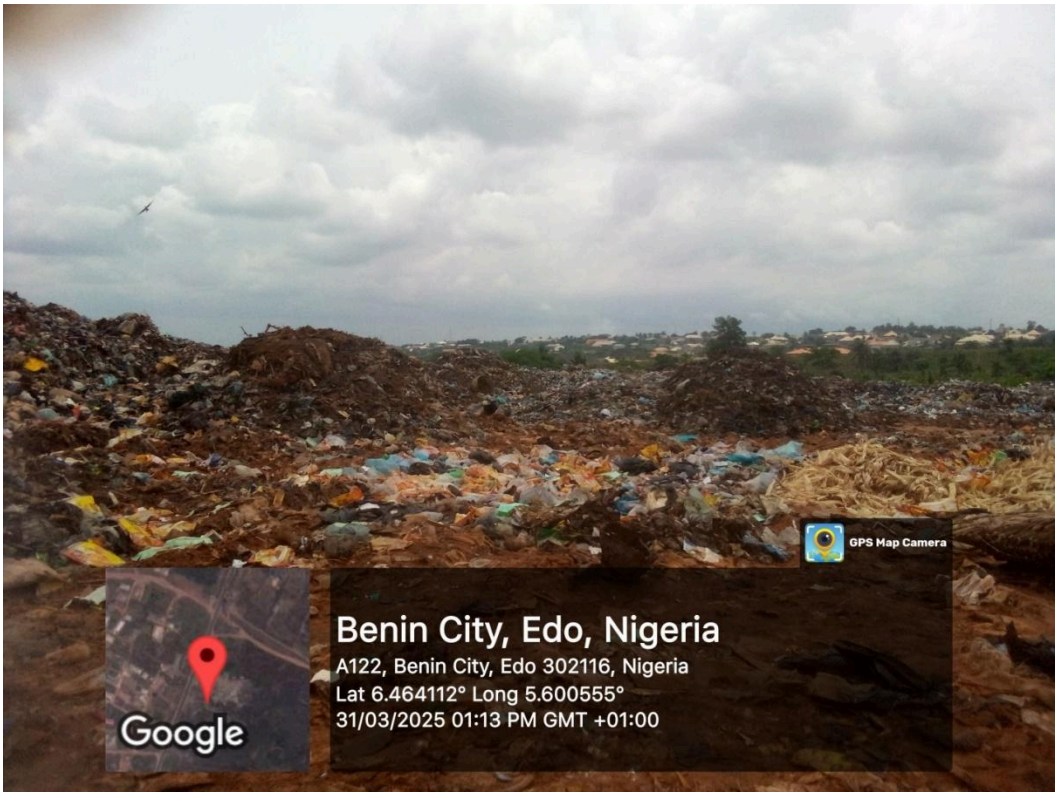


Plate 6: Typical composition of MSW in Benin City, Edo State

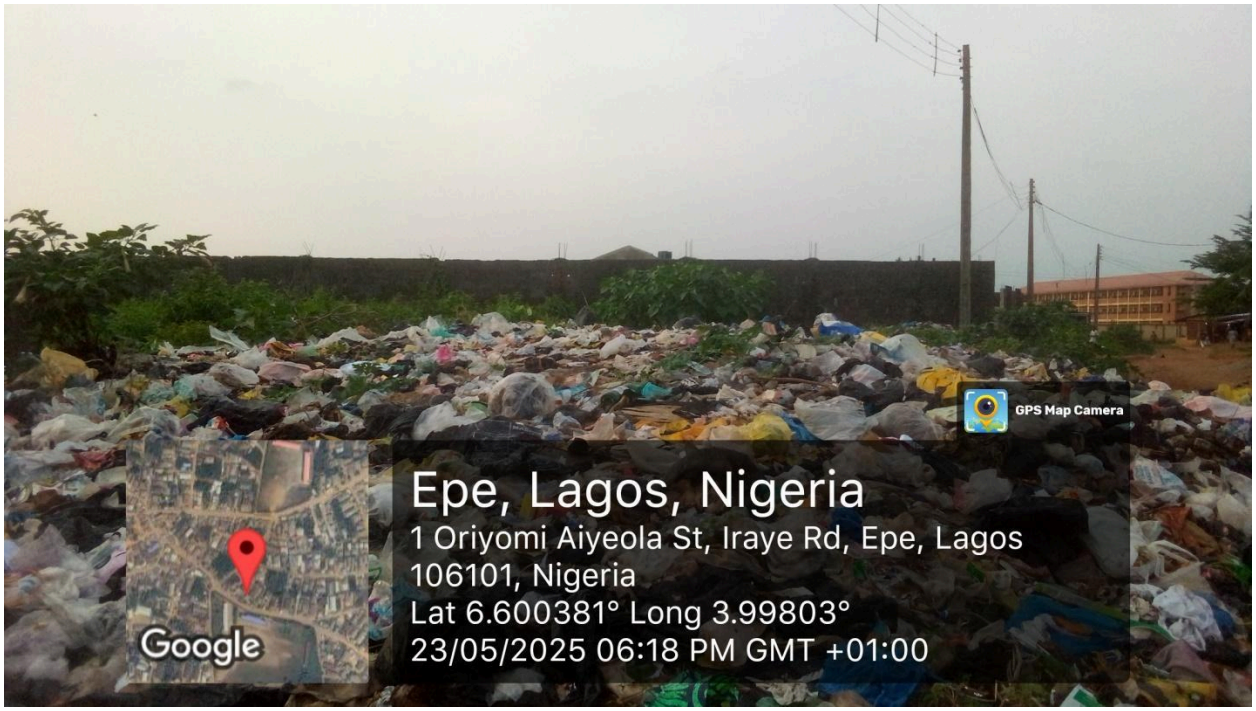


Plate 7: Typical composition of MSW in Lagos, State

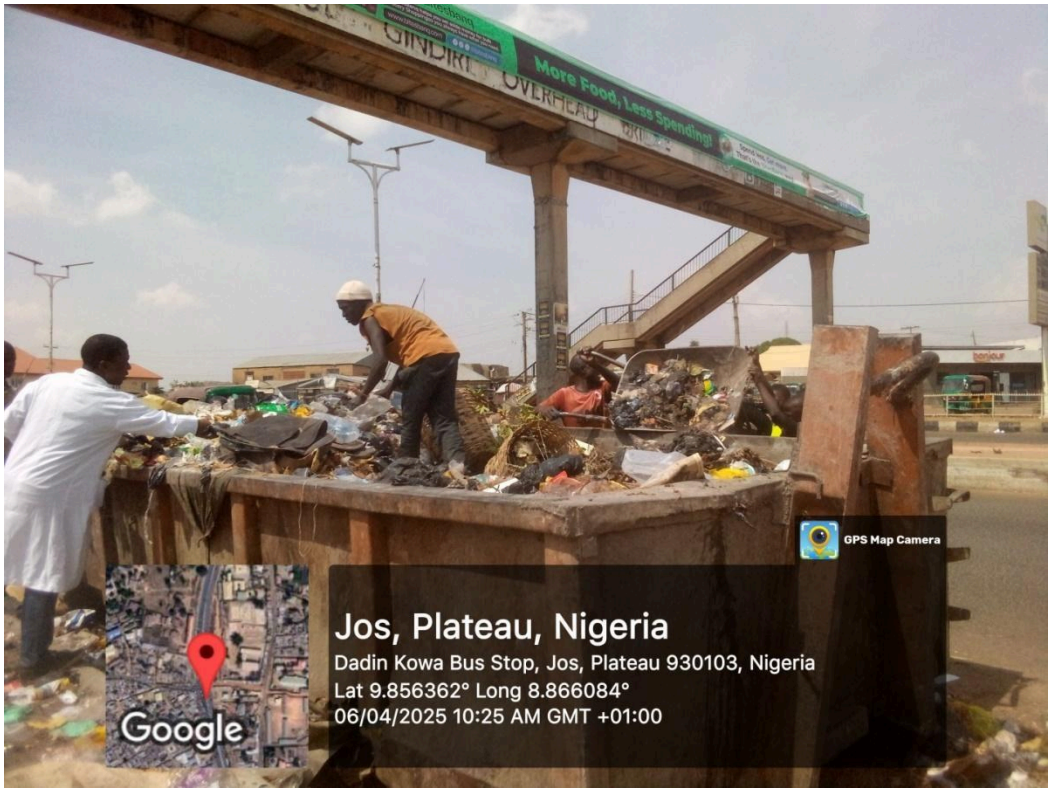


Plate 8: Typical composition of MSW in Jos City, Plateau State

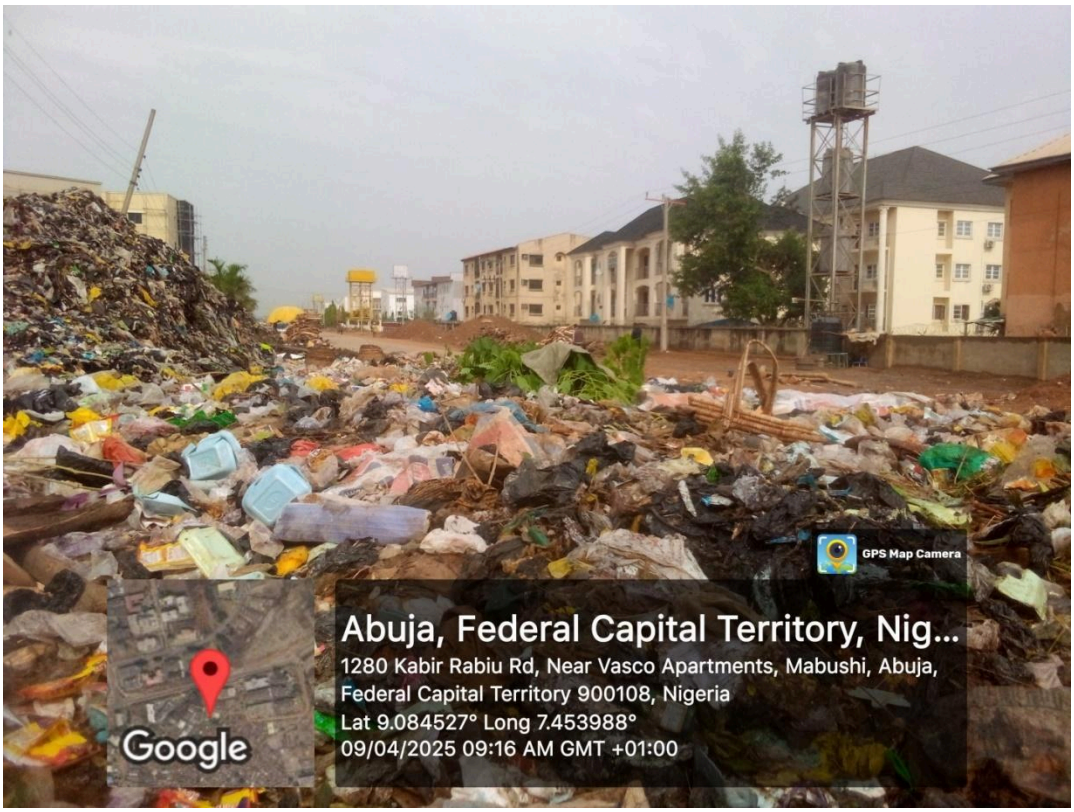


Plate 9: Typical composition of MSW in FCT Abuja

Methane is more than 80 times more potent than carbon dioxide as a climate pollutant accounting for nearly half of the 1 degree Celsius of warming humanity is experiencing. In order to sustainably manage MSW and achieve zero methane, the Multi-Solving Action to Methane Reduction in Nigeria (MAMRN) project, was conceived to demonstrate practical steps to reduce the production of methane gas resulting from organic wastes through the diversion of OFMSW as material for composing. The MAMRN project focus on key cities in Nigeria. These include Lagos, State, Benin City, Edo State, FCT, Abuja and Jos, Plateau State. The aim is to advocate for a strong national and subnational policies that align with Nigeria's commitment to the global methane pledge.

2. CLIMATE CHANGE-INDUCED FLOODING AND MSW DUMPSITES

Earth climate varies in space and time because of natural and anthropogenic forcing. Any change in the forcing factors and their interactions may result in climate variations leading to impacts on life on the Earth. Climate change refers to the change in the state of the mean and/or variability of climate properties over time, due to natural variability or anthropogenic activity (IPCC, 2007). Climate change can be traced using the observation technique and examining the rise in the land surface temperature, borehole temperature profile, sea surface temperature, and sea level (Global Climate Report 2018, Jackson 2019). An increase in all four independent parameters is the indication of global warming. More importantly, this increase is attributed to the increase in the global warming gases, such as CO_2 and CH_4 concentrations in the atmosphere. Study has shown that CO_2 has risen from 0.028 per cent in pre-industrial 1750 to 0.043 per cent today (Chophel 2022). In 2019, atmospheric CO_2 concentrations were higher than at any time in at least 2 million years (high confidence), and concentrations of CH_4 and N_2O were higher than at any time in at least 800,000 years (very high confidence) (IPCC, 2021). Since 1750, increases in CO_2 (47%) and CH_4 (156%) concentrations far exceed – and increases in nitrous oxide (N_2O) (23%) are similar to – the natural multi-millennial changes between glacial and interglacial periods over at least the past 800,000 years (IPCC, 2021). Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years (high confidence). Temperatures during the most recent decade (2011–2020) exceed those of the most recent multi-century warm period, around 6500 years ago [0.2°C to 1°C relative to 1850–1900] (medium confidence). Prior to that, the next most recent warm period was about 125,000 years

ago, when the multi-century temperature [0.5°C to 1.5°C relative to 1850–1900] overlaps the observations of the most recent decade (medium confidence) (IPCC, 2021). Methane is Earth's second most important anthropogenic greenhouse gas after carbon dioxide (Hartmann et al., 2013) and has a much larger global warming potential (Etminan , *et al*., 2016). CH_4 emissions are increasing (Jackson et al., 2020), resulting in a high growth rate of global annual average CH_4 mole fractions in the atmosphere, reaching up to 1911.88-0.59 parts per billion (ppb) for 2022, more than 2.5 times preindustrial levels (Nisbet et al., 2020; Lan et al., 2022), despite a temporary pause between 1998 and 2007 (Turner et al., 2019). Changes in climate indicators, namely temperature, precipitation, sea-level rise, ocean acidification and extreme weather conditions have been highlighted in a recent report by the United Nations Climate Change Secretariat (UNCCS, 2019) and most research documents in Nigeria. Also, climate hazards reported include droughts, floods, hurricanes, severe storms, heatwaves, wildfires, cold spells and landslides (UNCCS 2019).

Numerous researchers have demonstrated that the climate change impacts per country in the world vary and cannot be similarly quantified (Goglio et al., 2020; Lezaun, 2021). These impacts tend to vary in association with the adaptation and mitigation strategies in place and with the resources adopted by these countries (IPCC, 2018; Robinson, 2020; Ceci et al., 2021). According to Khan et al. (2021), climate change will make SSA more vulnerable than the developed countries of the world, thereby exacerbating the inequalities in respect of the incomes of most of the affected countries. This is more so, owing to the region's strong reliance on the agricultural and forestry sectors, erratic downpours, as well as technological advancement (Diallo et al., 2020; Kaganzi et al., 2021). According to IPCC (2021), Sub Sahara Africa is predicted to become the region exhibiting the greatest level of vulnerability by 2100, with agricultural losses likely to range between five (5) and 15% of the GDP. These impacts are also expected to be accompanied by rapid population expansion in the region, which is anticipated to increase from about 2 billion in 2005 to over 3.2 billion by the year 2050 (FAO, 2019).

According to the 2022 Environmental Performance Index (EPI), Nigeria falls in the 168th position out of a total number of 180 countries in terms of environmental sustainability (Oladapo 2022), and climate change is a serious environmental concern which has the potential to hinder the country from attaining key Sustainable Development Goals (SDGs) as well as international

commitments to environmental sustainability. In 2021, Nigeria was the world's 25th largest producer of greenhouse gas emissions. The largest emitters in the same period were China, the United States, India, Russia and Brazil (Boyle 2024). 37.4% of emissions in Nigeria came from CO_2, 44.6% came from CH_4, and 12.3% came from N_2O (Boyle 2024). In another study, it is reported that Nigeria Total Methane Emissions including Land-use Change and Forestry data is updated yearly, averaging 10.042 Tonne mn from Dec 1850 (Median) to 2023, with 174 observations. The data reached an all-time high of 327.053 Tonne mn in 1996 and a record low of 4.428 Tonne mn in 1850 (CEIC, 2023). Tiseo (2024) further revealed that Methane emissions in Nigeria reached a record high in 1996, having surpassed 327 million metric tons of carbon dioxide equivalents ($MtCO_2e$). Since then, Nigeria's emissions have experienced an overall downward trend and in 2022 stood at around 235 $MtCO_2e$. Nevertheless, Nigeria is still amongst the largest emitters of methane worldwide as shown by Boyle (2024). Methane is responsible for 20% of the global warming resulting from greenhouse gas emissions (Du et al., 2017), and municipal solid waste (MSW) landfills are the third largest anthropogenic source of methane (after agricultural and enteric fermentation) and account for 11% of global anthropogenic methane emissions (UNCC, 2015). If the MSW was consigned to a landfill then about 70 kg of methane (actual range 50-100 kg) could be released for each tonne of waste. Given the higher global warming potential of methane, this is equivalent to 1610 kg CO_2 per tonne of MSW (IEA Bioenergy, 2003).

The most significant impact of climate change in Nigeria include coastal inundation, heat wave, pollution and associated health risks, increased flooding, increased incidence of pests and diseases, damage to building infrastructure, coastal erosion, seal level rise all of which have implications for livelihood, agriculture, national development and attainment of the Sustainable Development Goals (SDGs), especially goals on No poverty (SDG 1), Zero Hunger (SDG 2), clean water/sanitation (SDG 6), Affordable/Clean Energy (SDG 7) and Climate action (SDG 13) emphasize the urgent need for. Open MSW dumpsite will exacerbate these impacts due to the activities of storm water runoff, which will dislodge dumpsites, hence exacerbate the pollution of water bodies and the spread of diseases into homes and schools. More so, FCT, Benin City, Lagos and Jos, Plateau States are some of Nigeria's fastest-growing urban areas. Due to the increasing influx of people into these cities overcrowding, slum and pressure on existing waste management facilities are inevitable. This has implications for flooding, including inundation of

waste dumpsites. As climate change is expected to intensify, flooding and inundation of waste dumpsites with associated pollution and health risks will increase. Moreover, Lagos, as a coastal city, is highly vulnerable to the effects of climate change, including sea-level rise, flooding, and coastal erosion (Fig. 1). More so, the city is densely populated with various expanding commercial and residential land use activities. Lagos state is expected to generate more waste due to population growth, production and consumption and when not sustainably managed will result in environmental pollution and health risks issues

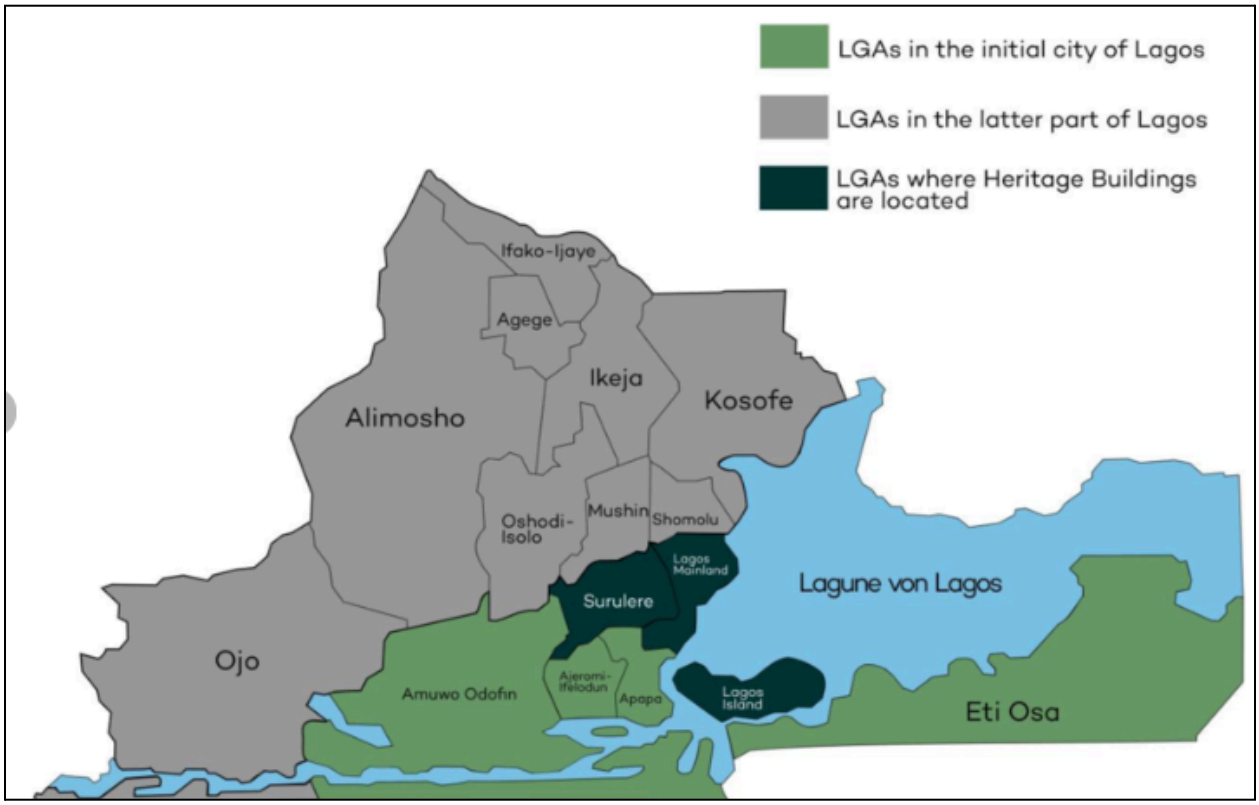


Fig. 1: Lagos State traversed by water and highly vulnerable to climate change
Sources: Bomi-Daniels (2022)

Apart from direct contribution to GHGs, the methane and carbon constituents of landfills are likely to pose the greatest explosion hazards. Plates 10-13, show a typical open dumpsite in parts of the country, which is capable of increasing climate change impacts during torrential rains and urban flooding.



Plate 10: A typical government approved open dumpsite facility in Benin City. Climate change induced flooding will exacerbate the effects of open dumpsites in Benin City.



Plate. 11: A typical approved open dumpsite facility in Epe Town. Flooding will exacerbate the effects of open dumpsites in Lagos.

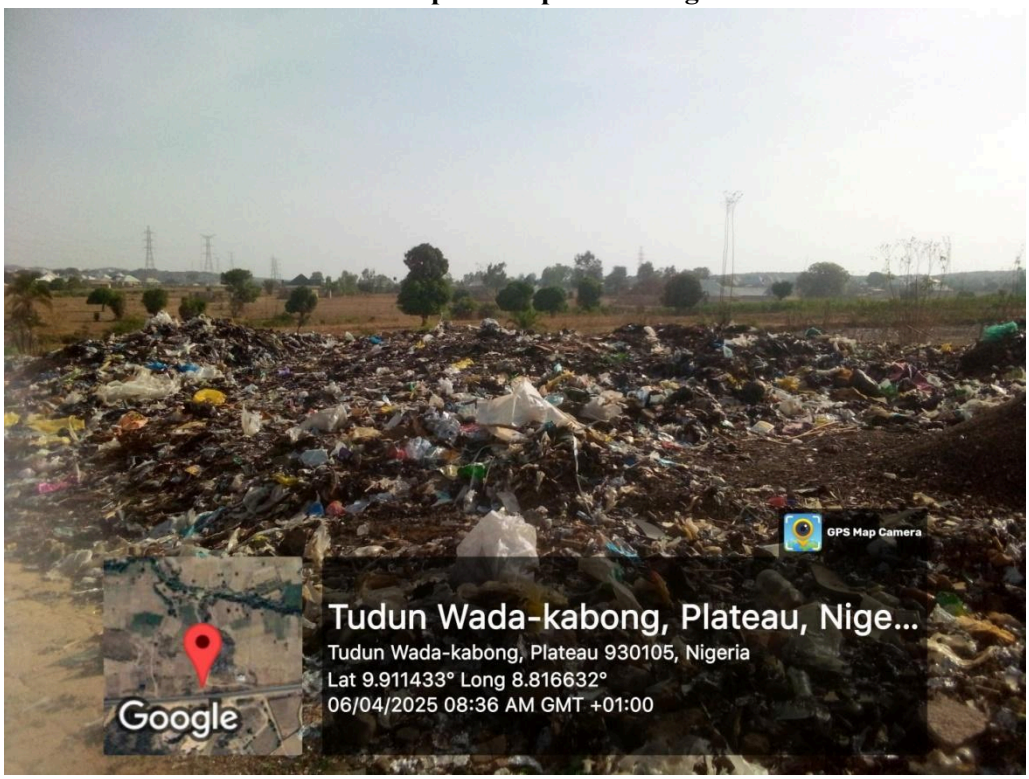


Plate 12: A typical government approved open dumpsite facility in Tudun Wada-Kabong, Jos, Plateau State. Climate change induced flooding will exacerbate the effects of open dumpsites in Plateau State.

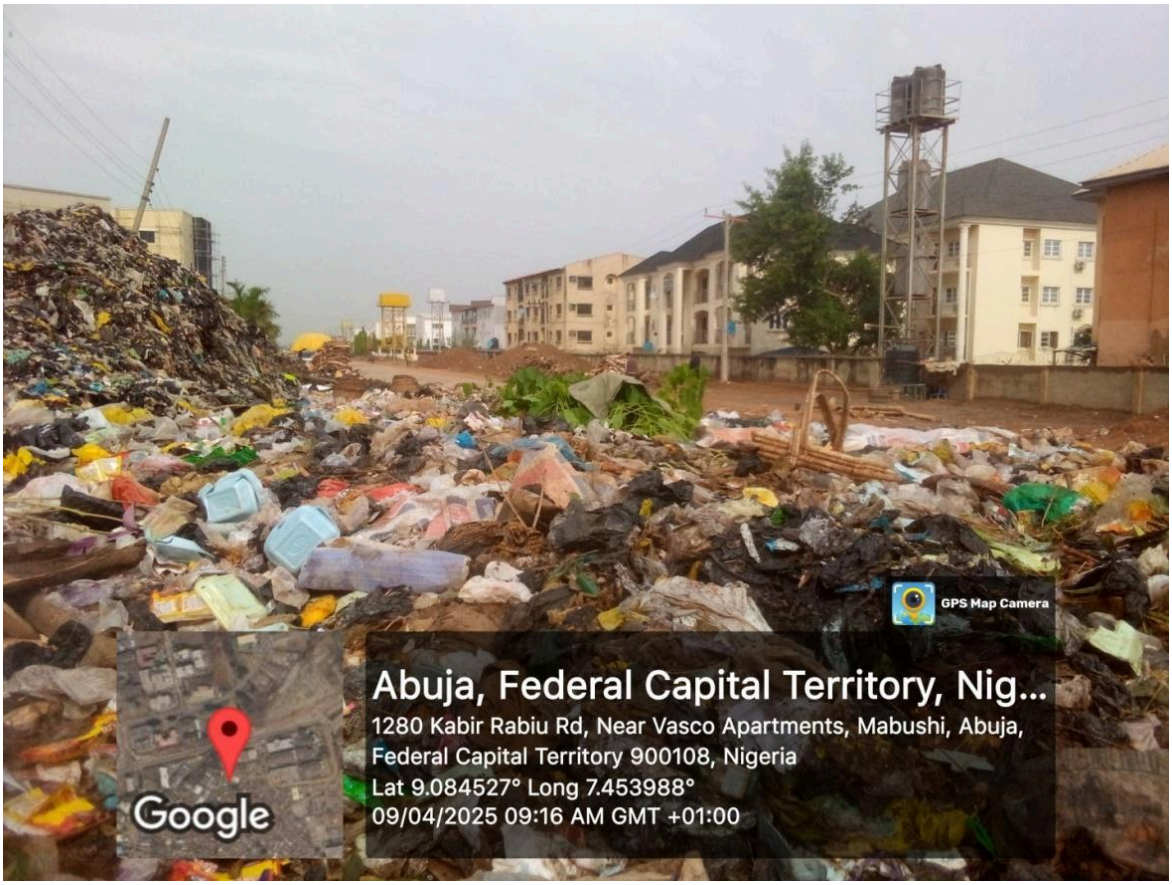


Plate 13: A typical government-approved open dumpsite facility in Mabushi, FCT, Abuja. Climate change -induced flooding will exacerbate the effects of open dumpsites in Abuja.

Following the adoption of the Climate Change Act on 18th November 2021, Nigeria is reinforcing its commitment to the reduction of GHG emissions by establishing more frameworks for achieving this reduction. Hence, complementing the effort of the Federal Government through a more aggressive action to address the causes and impacts of climate change through MAMRN project, which is aimed at reduction in GHGs emission levels in the waste sector, is timely as the project will provide bankable data and practical demonstration of Material recovery initiative all of which will inform policies on sustainable environment. MAMRN places greater emphasis on low-emission, zero waste initiatives and the diversion of materials from dumpsites.

3. ABOUT MAMRN PROJECT:

Project Rationale

Nigeria, a signatory to the Paris Agreement (PA), recognizes that the transition to low-emission development is essential to achieve sustainable economic growth by reducing greenhouse gases (GHG) and other social, economic, and environmental benefits that can lead to carbon emissions. In addition to National Determined Contributions (NDCs), which defines climate action until 2030, all parties aim to prepare and communicate Long-Term Low Emission Development Strategies (LT-LEDS), taking into account common but differentiated responsibilities and capacities, according to Article 4.19 of the Paris Agreement, in light of different national circumstances. In order to achieve this, the Federal Government of Nigeria developed its LT-LEDS system as part of its commitment to a low-carbon future, initially focusing on a long-term vision up to 2050. The vision provides clear direction to all stakeholders for a well-managed transition to a low-carbon economy that will grow existing and new sectors, and create new jobs and economic opportunities for the nation. The thrust of the vision is that by 2050, Nigeria will be a low-carbon, climate-resilient, and fast-growing circular economy, reducing current emissions by 50% and moving to zero emissions in all its sectors in a gender-responsive manner. The roles of non-state actors have in climate change mitigation and advocacy cannot be overemphasised such as influencing sustainable policies on global climate governance and generating evidence-based research to support NDCs, embody efforts by each country to reduce national emissions and adapt to the impacts of climate change.

In response to the growing need for climate action in the waste sector, leading environmental civil society organisations in Nigeria such as Green Knowledge Foundation (GKF), Centre for Earth Works Development (CFEW), Sustainable Research and Action for Environmental Development (SRADeV), Community Development Advocacy Foundation (CODAF), Sustainable Environment Development Initiative (SEDI), and PAN African Vision for the Environment—have jointly launched the "Multi-Solving Action for Methane Reduction in Nigeria" project. This initiative aims to significantly reduce methane emissions through zero-waste management practices, establish a Material Recovery Facilities (MRFs), purse policy

advocacy on methane reduction initiatives, and promote capacity building for key stakeholders. Organic manure is a natural fertiliser made from decomposed organic materials which helps improve soil health and plant growth while minimising the release of methane gas into the atmosphere. Compost manure is also known as a soil booster. This project will set up a material recovery facility (MRF), promote zero waste action and train farmers on the use of non-petroleum based chemicals throughout their farming activities. The project serves as an Agroecology concept that will ensure that the farming activities and practices of farmers in the target location are free of traces of petroleum chemicals and in the long run methane emission in the waste and agricultural sector will significantly be reduced. Through the Material Resource Facility, MAMRN project seeks to create a self-sustaining waste management system that not only cuts down waste on landfill but also promotes a circular economy through resource recovery create employment and projecting Nigeria as a leading nation in the drive for zero methane/waste. This approach aligns with the GAIA environmental justice principles and waste reduction goals as well as the global and National climate action initiatives as it becomes a model for sustainable urban waste management.

Project Justification

The need to embark on MAMRN drives from the following justification;

First is the need for Sustainable Solid WASTE management:

Sustainable municipal solid waste has garnered increasing attention especially as the pressure of urbanization, industrialization, and population growth on waste generation continue without corresponding capacity of municipal authorities to handle waste collection. Nigeria population at the moment is over 230million, and this figure according to the United nations projection will increase to between 359 and 450 million by 2050. This increment will have implications for waste generation as well as exacerbate existing solid waste management crisis in Nigeria. Open dumping of waste and inadequate municipal solid waste has given rise to range environmental consequences, including the contamination of water bodies and blockage of drains hence increasing the occurrence of floods, and the transmission of infections through the breeding of vectors. This situation poses risks not only to the environment but also to all living organisms. These concerns underscore the critical importance of establishing a comprehensive and

sustainable approach to MSW management systems involving organic waste reduction from waste streams through Material recovery initiative. This justification is in alignment with this global shift towards the concepts such as the circular economy, sustainable development and low-carbon industry.

Second is the need for GHG reduction as Panacea to climate change mitigation:

Global warming is an on-going environmental issue that threatens human existence and human activities have been implicated in GHG emission. Methane is Earth's second most important anthropogenic greenhouse gas after carbon dioxide. Open waste dumpsites is an important source of methane production through the decaying of organic waste over time under anaerobic conditions Coupled with open dumping is the waste open-burning practice, which generates other gases such as CO_2, N_2O and particulate matters all of which negatively affects public health. In view of this, there is need for a holistic study that will evaluate the potentials for an integrated waste management systems (ISWM), ideally incorporating waste reduction, and reuse as sustainable solution to GHG reduction leading to climate change mitigation. This justification is in line with the 2030 Agenda for Sustainable Development of the United Nations which prioritizes effective MSW management to decrease cities' environmental footprint.

Third is to support National Government's efforts towards meeting International obligation to tackle global Warming:

Nigeria is at the forefront towards responding to its obligations to the United Nations Framework Convention on Climate Change (UNFCCC). This can be seen in National GHG Inventory Management System (NGHGIMS) established in 2018, an institutional arrangement, made up of Sectorial Working Groups, under the Federal Ministry of Environment. The aim of this initiative is to management of the entire national GHG inventory process and ensures that delivery of an inventory is of good quality that meets international standards (National GHG Inventory Report, 2021). Ministry collaborates with the inventory stakeholders in the various sectors to undertake management of activity data and emission factors, compilation of emission estimates, quality control/quality assurance, improvement planning, and preparation of the National Inventory Report (NIR). This national Initiative of the Federal government further justifies the need for the present study as findings from the study will be key in policy making as

well as compliment the effort of the National GHG Inventory Management System (NGHGIMS).

4. PROJECT SUMMARY

The waste composition of Nigeria is over 60% organic, yet the absence of a well-structured data-driven source segregation waste management program has led to the country's failure to benefit from such organic wastes. The cities of Lagos, Jos, Benin and Abuja represent diverse urban typologies for national scale-up of Low Methane initiative. The Multi-solving Action to Methane Reduction in Nigeria seeks to bring together a host of non-governmental organisations that work on waste and climate change in a movement-building style to implement a comprehensive organic waste diversion program that can deliver measurable and verifiable results. The program will engage informal waste picker groups and municipal and metropolitan leaders to close landfills and dumpsites and create multiple streams of income as co-benefits from lowering methane emissions.

The program will leverage the support of national and sub-national governments through existing pilots to establish a waste resource site for innovations, including composting, Black Soldier Fly farming and recycling of other waste streams. This will lead to the creation of a sustainable waste management model that can be replicated across Africa. The model will also leverage the expertise of diverse stakeholders and emerging tools to capture and document comprehensive data on waste management in Nigeria. This makes the model a catalyst for building evidence for zero-waste models as climate solutions and aiding national governments in setting fair and equitable waste methane reduction targets. The model will also use initiatives such as Zero Waste Parliament, Zero Waste Ambassadorship and extensive advocacy campaigns to create an appetite for stronger political will for policy support.

5. OVERALL PROJECT OBJECTIVES

The primary objective of this project is to significantly reduce methane emissions in Nigeria through the implementation of sustainable waste management practices, community engagement, and policy advocacy. Specifically, the project aims to;

i. Data-driven campaign to promote Zero Waste Implementation

1.1 Conduct extensive baseline surveys in project areas to identify methane emission hotspots and design a door-to-door campaign to engage communities across five cities, focusing on source segregation of waste.

1.2 Institutionalise avoided methane action by recruiting and training Zero Waste Ambassadors (**ZeWA**) and zero waste Parliaments (**ZeWP**) in Lagos, Abuja, and Benin cities to help propagate the message on low methane activities.

1.3 The establishment of the Zero Waste Farmers Network. This includes creating a Zero Waste Farmers Network that will participate and later lead the home composting training and conduct workshops to ensure efficient capacity building for communities to practise urban farming using the compost they produce.

ii. Establishment of Waste Resource Centres in Lagos and Abuja: Create fully operational waste resource centres equipped with facilities for training and innovations along the waste value chain. The following will be among the activities the centres will serve.

1.1 Training of waste pickers, collectors and environmental officers of the municipalities with the cities of Lagos and Abuja. The centres will serve as places to demonstrate sound waste management mechanisms and as a space for capacity building for various frontliners to support the project's community sensitisation and the implementation of the source segregation campaigns.

1.2 Convert organic waste into compost fertiliser to serve local farmers and improve urban food systems in Lagos and Abuja. These centres will serve as hubs for ensuring efficient methane emissions activities as they will process organic waste into valuable compost and a range of other products as co-benefits.

1.3 Develop Black Soldier Fly (BSF) Farms**:** Set up and operationalise two large-scale BSF farms in Lagos and Abuja to process organic waste into high-protein animal feed and organic fertiliser. This initiative will reduce waste and provide economic benefits to local communities.

iii. Integrated Media Campaign on low-methane action as a climate intervention

This will engage youth and academia using various online and offline platforms to spur a national conversation on sustainable waste management, specifically the nexus between sound waste management and climate change adaptation efforts. It will also engage households and community leaders, encourage youth and vulnerable groups to establish community composting sites and distribute compost bins to promote eco-preneurship.

iv. National & City-Level Policy Support:

Conduct a national desktop study and stakeholder mapping to identify and address gaps in methane reduction initiatives. Build stakeholder capacity, engage the media, and advocate for policies supporting Nigeria's commitment to methane emission reduction.

6. MAMRN AND THEORY OF CHANGE

Nigeria faces significant environmental challenges due to over 60% of its waste being organic, combined with a lack of structures to manage organic waste, data-driven waste management programs. This has resulted in missed opportunities to benefit from organic waste and has led to high methane emissions from unmanaged landfills and dumpsites. The root causes include inadequate waste segregation, lack of community awareness, insufficient waste management infrastructure, and limited policy support for sustainable practices.

If…

the successful output of our activities

The successful output of our activities includes the establishment of a Material Recovery Facility (MRF), community engagement programs, capacity building for waste management stakeholders, development of composting and BSF farms.

Then…

the change that has been made as a result to the successful output of our activities

There will be a significant reduction in methane emissions, improved waste management practices, increased community awareness and engagement, strengthened capacity of waste management stakeholders, economic empowerment through new income streams, enhanced urban food systems and robust data collection for policy-making.

Because…

Underlying assumptions of why the successful output of our activities will make the positive change we want to see

Stakeholder Engagement: Key stakeholders, including local communities, government agencies, and waste management entities, will actively participate and support the project.

Policy Support: Government policies and regulations will favor the adoption and implementation of methane reduction initiatives.

Community Participation: Local communities will be receptive to training and educational campaigns, and will actively engage in sustainable waste management practices.

Funding Availability: Adequate funding and resources will be available throughout the project duration to ensure successful implementation of all activities.

Technical Feasibility: The technologies and methodologies proposed for methane reduction and waste management will be effective and adaptable to the local context.

Market Demand: There will be a consistent market demand for the products derived from organic waste, such as high-protein animal feed and organic fertilizer.

Context….

This Methane Reduction Project in Nigeria is initiated against the backdrop of increasing global awareness and commitment to mitigating climate change impacts. Nigeria, being one of the largest producers of oil and gas, faces significant challenges with methane emissions, a potent greenhouse gas. Rapid urbanization and inadequate waste management infrastructure exacerbate the situation, leading to environmental degradation and public health concerns.

Context: This initiative aligns with Nigeria's Nationally Determined Contributions (NDCs) under the Paris Agreement, aiming to reduce greenhouse gas emissions and promote sustainable waste management practices.

Risks: Key risks include potential resistance from stakeholders due to changes in waste management practices and logistical challenges in project implementation.

Long-Term Sustainability: By training local waste pickers, farmers, establishing operational frameworks, and promoting zero-waste practices, the initiative aims to create self-sustaining systems. Continuous public awareness campaigns and stakeholder engagement will foster a supportive environment for sustained methane reduction efforts, contributing to Nigeria's broader environmental and climate goals.

7. MATERIAL RECOVERY FACILITY EXPECTED PROJECT BENEFITS

1. **Significant Reduction in Methane Emissions:**

   Reduced methane emissions from landfills and dumpsites in Lagos, Abuja, Jos, and Benin due to enhanced waste segregation, composting, and Black Soldier Fly (BSF) farming practices

2. **Enhanced Waste Management Practices:**

   Implementation of data-driven, sustainable waste management practices in target cities, leading to more efficient and environmentally friendly waste disposal methods

3. **Increased Community Engagement and Awareness:**

   Higher levels of community participation and awareness in sustainable waste management and methane reduction efforts through targeted door-to-door campaigns, training programs, and media outreach.

4. **Strengthened Capacity of Waste Management Stakeholders:**

   Improved skills and knowledge among waste pickers, collectors, environmental officers, and Zero Waste Ambassadors, resulting in more effective waste management and methane reduction initiatives

5. **Economic Empowerment and Livelihood Opportunities:**

   Creation of multiple streams of income for local communities through the establishment of composting operations and BSF farms which will provide high-protein animal feed and organic fertiliser.

8. ORGANIZATIONAL DESCRIPTION AND PROJECT KEY PARTNERS

1. Global Alliance for Incinerator Alternatives (GAIA)
2. Green Knowledge Foundation (GKF)
3. Sustainable Research and Action for Environmental Development (SRADev)
4. Community Development Advocacy Foundation (CODAF)
5. Centre for Earth Works (CfEW)
6. Sustainable Environment Development Initiative (SEDI)
7. PAN African Vision for the Environment (PAVE)

The Global Alliance for Incinerator Alternatives (GAIA): GAIA was formed in 2000 by organisations from around the world working independently on environmental justice issues. GAIA works on solutions-oriented efforts like "zero waste"; challenging international plastic waste trade; and addressing air pollution. GAIA includes over 1000 member organisations spanning 90 countries and representing a wide array of experiences, cultures, and backgrounds. In many places, member efforts have worked in full cooperation with local waste picker organisations. GAIA seeks to lay the groundwork for significantly increased methane reduction from the waste sector, through data-driven implementation and efforts to create the conditions for effective investment in these solutions.

Green Knowledge Foundation (GKF): GKF is an environmental non-profit organisation based in Warri, Delta State, Nigeria, which empowers individuals and communities to become informed stewards of the environment, driving a shift towards sustainable development through innovative education, collaborative partnerships and impactful initiatives. Over the years, GKF has worked in various fields of environmental development, ranging from environmental education to waste management, environmental justice, waste management, clean air, water, sanitation, and hygiene (WASH). GKF has been a critical player in the environmental justice movement in Nigeria, with a burning desire to promote environmental awareness and a team of passionate environmentalists. GKF has hosted the GAIA Nigeria coordination work since 2022

and, in this role, supports the broader Nigeria network.

Sustainable Research and Action for Environmental Development (SRADev Nigeria) is a professional, non-governmental, non-profit think tank in environmental health research and development, advocacy and action organisation. It seeks to be the voice for environmental development in Africa particularly, Nigeria, while acting as a catalyst, advocate, educator and facilitator to promote the wise use and sustainable development of the environment. The organisation was formed on 7th November, 2003, with its Headquarters in Lagos. SRADev Nigeria promotes sustainable development by facilitating sound environmental practice, exchange information, building bridges of understanding on environmental health and natural resource conservation in a sustainable way and to ensure that the local people are put on the drivers' seat in the sustainable management of the environment.

Center for EarthWorks (CFEW) is a Research driven, youth led non-governmental organisation That is Passionate about Securing the Earth. Cfew (based in the city of Jos) was founded with the vision to contribute achieving environmental sustainability and and fostering youth participation in sustainable development. The mission of CFEW is to develop, initiate and foster platforms through competent environmental programme, environmental education, conducting related scientific research and continually advocate and implement projects that promotes and mainstream sustainable development to mitigate challenges that confront us today. The CFEW network is spread across Nigeria with extended partnerships in other African countries. The CFEW team has extensive experience working on waste issues and engaging with the informal sector through projects funded by the CACC to mainstream organic waste. CFEW has organised community clean ups and waste audits in different parts of Nigeria.

Community Development Advocacy Foundation (CODAF) is a non-governmental organisation that is registered in Nigeria with focus on environmental advocacy work in Nigeria to bridge the communication gap between policymakers and the grassroots. This mandate is anchored on article 24 of the African Charter on Human and Peoples' Rights which states that "All peoples shall have the right to a general satisfactory environment favorable to their development". CODAF is based in Ughelli, Delta State.

The Pan African Vision for the Environment (PAVE) is a Lagos based non-profit, non-political, non-governmental organisation established with the aim of promoting sustainable

development through research, documentation, policy dialogues, workshops, advocacy and consultancy services. PAVE deals with development issues in their environmental and socio-economic aspects with emphasis on the attainment of the Sustainable Development Goals (SDGs) targets regarding water and sanitation and other related human settlement issues including Agricultural Value Chain promotion, Gender, Disaster Risk Reduction (DRR), Climate change and Clean Energy promotion, Waste Management including E-Waste and Chemical Management and Stakeholder Engagement.

Sustainable Environment Development Initiative (SEDI): is a non-governmental organization (NGO) registered in Nigeria and fills gaps created in the environment development sector by promoting a people-centred approach. It has its headquarters in Benin City, Edo State, Nigeria. SEDI is an NGO focal point coordinator for Water, Sanitation and Hygiene (WASH) in Edo State and is also a National Working Group Member, Climate Change Network Nigeria.

SEDI led a campaign project supported by Global Alliance for Incinerator Alternatives (GAIA) on 'Pathway to Municipal Waste Management in Edo State' campaigning for a non-incineration policy on waste incineration in landfills and the facilitation of the 'Otofure Dumpsite Waste Pickers Constitution' for waste pickers. SEDI is Sustainability Advocate, Circular Economy Benin-City club: devoted to the design and implementation of circular economy strategies in the waste management sector using the circular economy business model to reduce pollution and create green jobs. SEDI is currently leading a project on 'Community plastic pact towards a greener future' in Edo state.

9. BASELINE STUDY BEFORE MATERIAL RECOVERY FACILITY

The Baseline survey for the Multi-Solving Action for Methane Reduction in Nigeria (MAMRN) project establishes the foundational framework for assessing the current state of waste management practices, stakeholder engagement in the project's target states. The baseline study serves as a critical reference point for evaluating the project's feasibility and potential impacts in Benin City (Edo State), Jos (Plateau State), and FCT (Abuja). The survey was carried out to also assess key indicators, including, the current waste management landscape, focusing on landfill use, composting adoption opportunities, and methane emissions, Farmers' knowledge and practices related to organic waste composting and the use of non-petroleum-based fertilizers, state government policies and stakeholder engagement in sustainable waste management,

Community awareness and participation in waste diversion and methane reduction initiatives. The MAMRN project, implemented by Green Knowledge Foundation, Sustainable Environment Development Initiative (SEDI), Centre for Earth Works Development (CFEW), Community Development Foundation (CODAF), PAN African Vision for the Environment Green Knowledge Foundation (GKF), aims to reduce methane emissions by promoting zero-waste strategies, enhancing organic waste composting, and strengthening local waste management systems. Through this report, Green Knowledge Foundation and its partners will Sustainable Environment Development Initiative (SEDI), Centre for Earth Works Development (CFEW), Green Knowledge Foundation (GKF) and their partners will establish baseline benchmarks to monitor progress, refine intervention strategies, and contribute to the broader discourse on sustainable waste management and climate action in Nigeria. The findings will strengthen policy discuss on national strategic interventions and advocacy efforts, ensuring that methane reduction efforts are data-driven, community-centered, and policy-oriented.

9.1.Objectives of Baseline Survey

To achieve the survey aim, the following objectives were pursued;

- Estimation of methane emission from open or designated dumpsites in Benin City, (Edo State), Jos (Plateau), FCT (Abuja).
- Carry out MSW characterisation to determine components of MSW in in Benin City, (Edo State), Jos (Plateau), Lagos State, FCT (Abuja). Information on waste components and the frequency of generation, offers investors on-the-surface information of resource abundance
- Utilise geospatial analysis (GIS) to map methane hotspots in Lagos, Abuja, Jos and Benin City).
- Establish baseline information for households, business owners, fruits sellers, farmers, waste pickers and local government officers. This information will serve as socio-economic/demographic threshold before, during, and after implementation of the Material Recovery Facility (organic waste resource recovery facilities) in Epe Town (Lagos), Abuja (F.C.T.), Jos (Plateau State) and Benin City (Edo State).

- Examine the current solid waste disposal practices in Lagos, Abuja, Jos, and Benin City) in terms of the strengths, weaknesses, opportunities, and threats of existing disposal practices.
- Examine organic waste composting potentials in Lagos, Abuja, Jos, and Benin City) in terms of resource abundance, community willingness to be incorporated in the Recovery process
- Identify key players in the multi-solving actions for zero waste, their roles, anticipated challenges, and prospects.
- Develop a material recovery model for the Material recovery facility.

9.2.Scope of Baseline Evaluation:

As part of the program learning process, the consultants conducted a mixed methods evaluation to confirm baseline values/indicators before commencement of the MRF Implementation. The scope of this evaluation includes:

- A comprehensive baseline survey to assess the current state of waste management, challenges and opportunities in Lagos, Abuja, Jos and Benin City)

❖ Investigate waste sorting, composting potentials and recycling practices, participation of waste pickers and managers and methane emissions resulting from landfill waste decomposition.

❖ Assess the current use of compost manure and chemical fertilisers, farmers' understanding of the benefits of composting and the obstacles to its adoption.

❖ Analyse existing waste management policies, composting guidelines and the role of local authorities in managing organic waste, landfill operations and reducing methane emissions.

❖ Utilise geospatial analysis (GIS) to map methane hotspots in Lagos, Abuja, Jos and Benin City)

❖ Evaluate public perceptions of zero waste, community involvement in waste segregation and the readiness to embrace zero waste.

❖ Analyze all data to provide actionable insights for the establishment of a Material Recovery Facilities and the design of the Zero Waste Ambassadors Campaign.

- ❖ Prepare and submit a detailed report outlining the project's findings, recommendations and proposed strategies for implementation.

9.3. **Evaluation Methodology:**

The baseline study for the Multi-Solving Action for Methane Reduction in Nigeria (MAMRN) project employed a mixed-methods approach, integrating quantitative, qualitative, and environmental assessment techniques to comprehensively evaluate the existing waste management landscape, waste characterization, methane emissions, and stakeholder engagement in Lagos, Abuja, Jos and Benin City). This approach ensures a robust understanding of baseline conditions while capturing both quantitative trends and nuanced stakeholder perspectives. Findings from the study are expected to guide the implementation of key project components, including the establishment of a Material Recovery Facility, farmer training programs, and zero-waste community initiatives. The study was conducted in a participatory and iterative manner, ensuring active engagement with local stakeholders, waste pickers, farmers, community members, and government authorities.

9.3.1. The Methodology include:

- ❖ Households and other key indicators surveys to assess waste disposal habits, composting practices, and awareness levels regarding methane reduction.
- ❖ Key Informant Interviews (KIIs) with local government officials, waste management authorities, environmental NGOs, and business owners to understand policy implementation and sectoral challenges.
- ❖ Focus Group Discussions (FGDs) with farmers, waste pickers, market leaders, and community representatives to gain deeper insights into waste segregation practices, organic waste reuse, and local barriers to adoption.
- ❖ Waste Management Facility Assessments to evaluate the existing infrastructure for waste collection, composting, and recycling.
- ❖ Policy and Regulatory Reviews to analyze existing legislation and policy frameworks on waste management and methane reduction.

- ❖ Environmental Assessments will be carried out to characterize waste and estimate current methane emissions from organic waste decomposition, using primary data and modeling techniques.
- ❖ GIS mapping of methane hotspots

9.3.2. Key Elements of the Methodological Approach

- ❖ Quantitative Methods – These provided measurable indicator of waste management practices, community awareness levels, MSW characterisation and methane emissions.
- ❖ Qualitative Methods – These were used to explore perceptions, behaviours, and policy challenges, offering a deeper contextual understanding of the baseline conditions.
- ❖ Environmental Assessment – This was used to carry out waste characterisation and estimate current methane emissions from waste decomposition, providing a critical scientific basis for evaluating intervention impact.
- ❖ Policy and Regulatory Review – This provided information on the existing policy landscape and identified gaps in waste management governance.

9.3.3. Data Collection Methods

Target populations were both purposively and randomly sampled across the project intervention areas to generate a minimum sample population for each State. A total number of 125 respondents were sampled from each State. Field staffs were first trained before proceeding to the field (Plates 14- 16 illustrate training of field officers). The questionnaire was used to identify and analyze the key respondent's information, including the critical entry or leverage points as well as the prevailing and current socio-economic aspects of the beneficiaries (see Plates 17-20 for interview/questionnaire distribution sessions). This effort aimed at gaining insights on the influences of existing drivers, and force fields around the socio-economic and environmental behaviour of the respondents in order to examine changes. The total target population was both purposively and randomly sampled in each state to generate a minimum sample population for each state (Table 1).



Plate 14a: Training of field officers before distribution of questionnaire, in Epe, Lagos State



Plate 14b: raining of field officers before distribution of questionnaire, in Epe, Lagos State

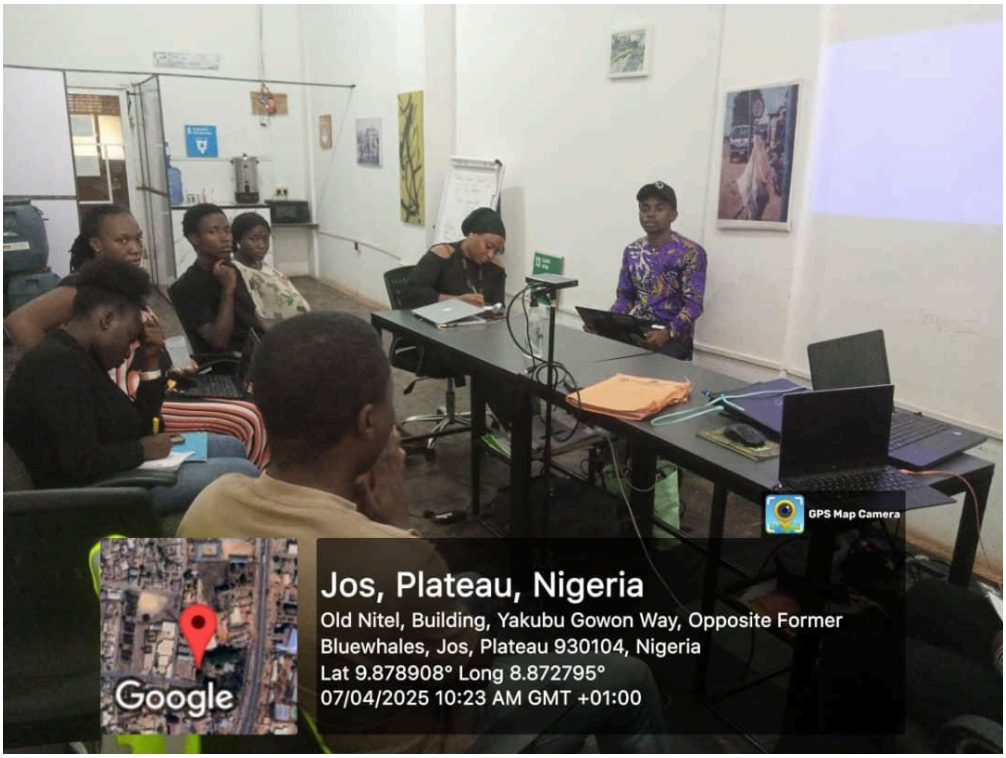


Plate 15: Training of field officers before distribution of questionnaire in Jos Plateau State

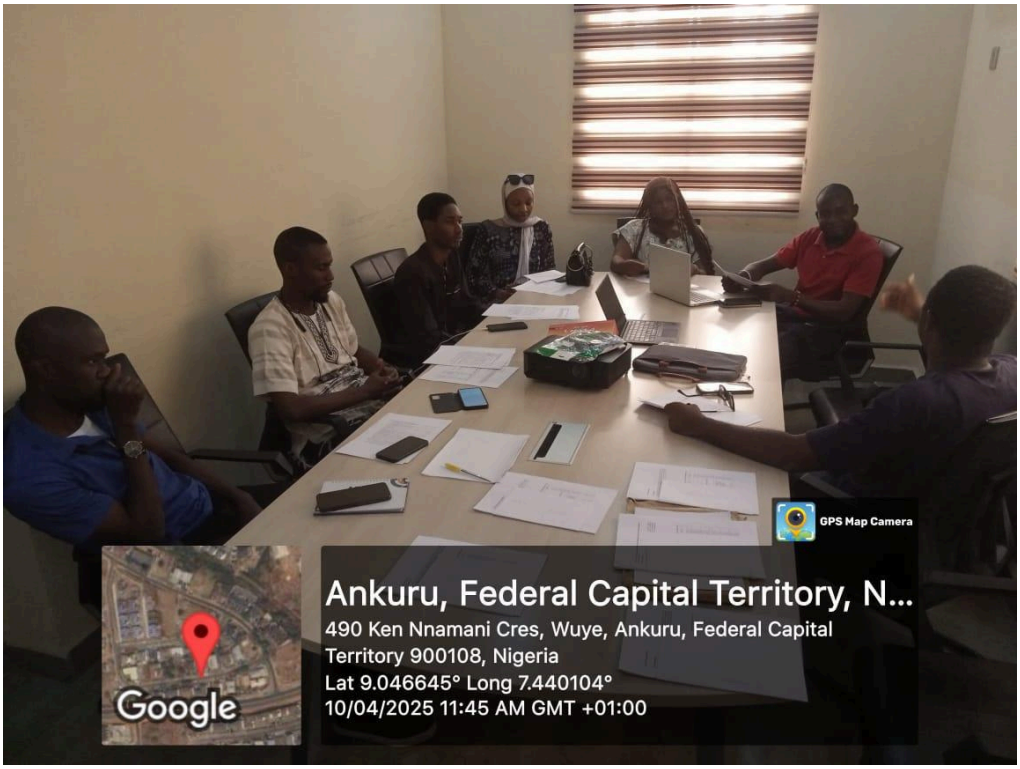


Plate 16: Training of field officers before distribution of questionnaire FCT, Abuja

9.3.4. Research Design

The study adopted an exploratory research design, for investigating a phenomenon with little or no previous research. This design allows the researcher to gather preliminary data, identify problems, and develop assumptions. Studies have shown that this research design provides a deeper understanding of phenomena by exploring the "why" behind observed events, unlike descriptive research which simply outlines what is happening (Akhtar, 2016; Olajide and Lawal, 2020;Tegan, 2021). More so, this approach allows for the identification of causal relationships, leading to better-informed decision-making and potentially more effective solutions (Voxco, 2021; Tegan, 2021). Notwithstanding these benefits, study has shown that most of the times, exploratory research involves a smaller sample, hence the results cannot be accurately interpreted for a generalized population (Saka et al., 2023). The study also adopts a cross-sectional design research method, enabling the researcher to collect data at a single point in time. One of the advantage of this method is fact that they allow researchers to gather data from a large sample at a single point in time, providing a snapshot of a population's characteristics, opinions, or behaviors (Wang and Cheng, 2020). This makes the approach ideal for identifying trends, associations, and prevalence of certain characteristics within a population (Setia, 2016). However, a major limitation of a cross-sectional approach is that it cannot determine cause-and-effect relationships. For example, while it may identify a relationship between two variables, it cannot show whether one caused the other (Indeed Editorial Team, 2025), and this is because the data is collected at a single point in time, without context for what happened first.

9.3.5. Population of the Study

The study population are selected households, farmers (food, fruits and vegetable farmers), fruits/vegetable sellers, waste management officials and Waste pickers. These categories of people were selected due to their roles in waste management and their anticipated roles in the material recovery process, including waste generation, scavenging (Waste pickers) and policy framework. More so, sampling of these respondents was driven by their willingness to participate in the questionnaire, accessibility to the respondents and formal permission from waste management authority to access and interview informal waste pickers at the dumpsites.

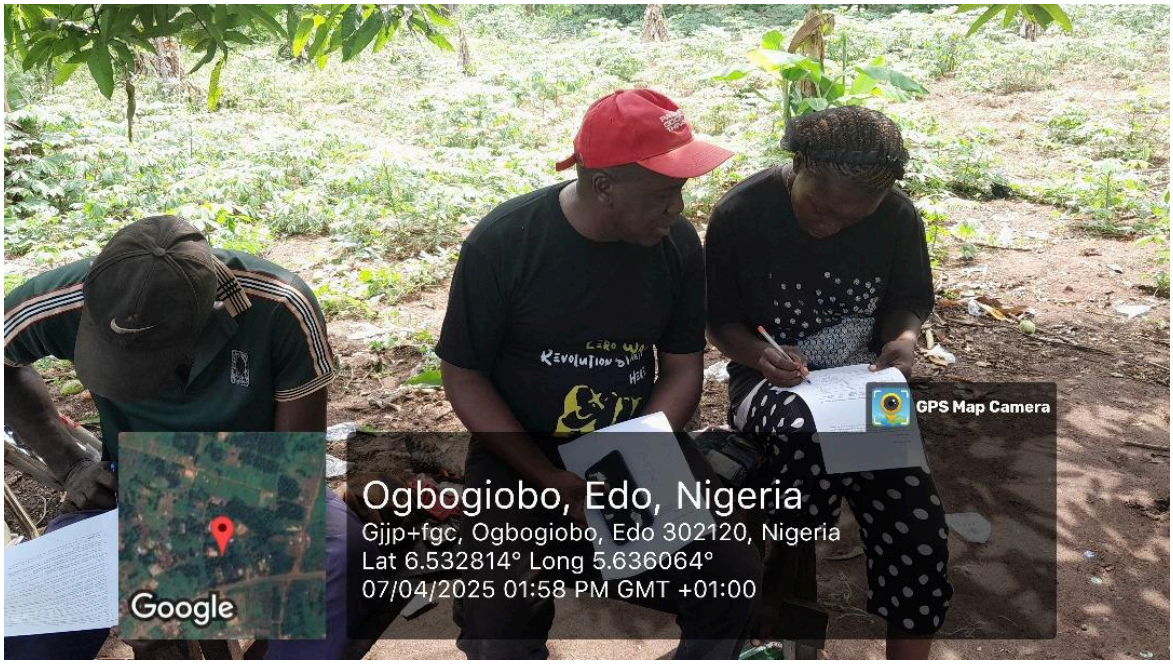


Plate: 17a: Interview session with farmers in Edo State



Plate 17b: Interview session with local palm oil processing business owner in Edo State

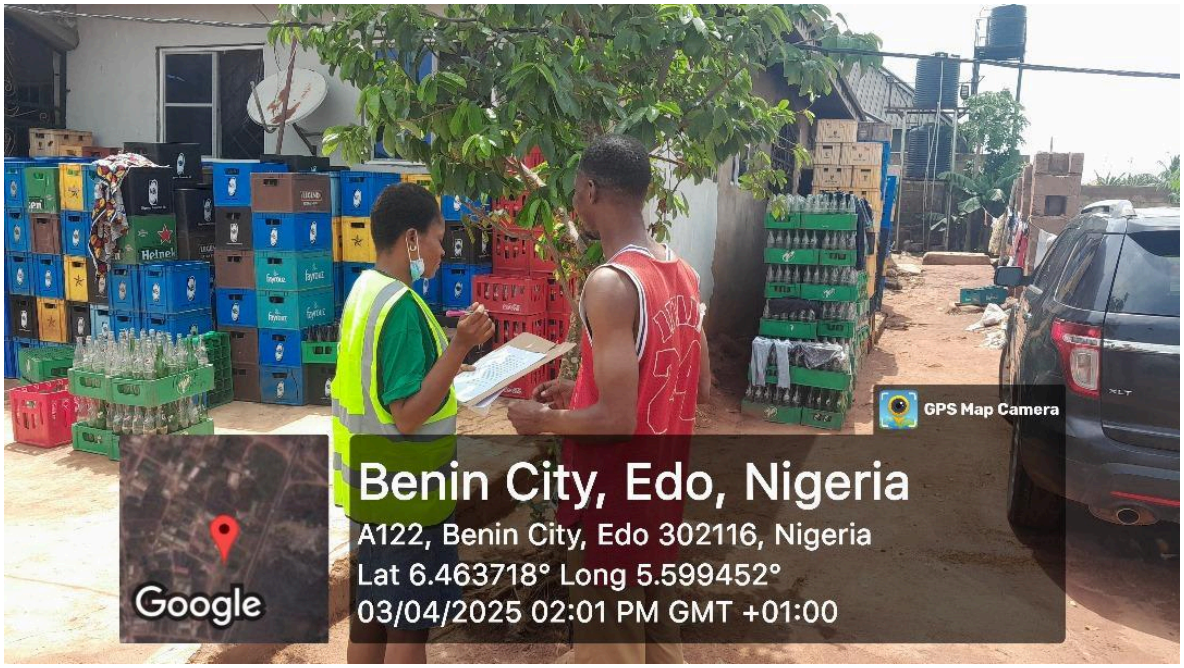


Plate 17c: Interview session with household in Benin City in Edo State



Plate 17d: Interview session with Waste management officer in Benin City in Edo



Plate 17e: Interview session with fruit sellers in Benin City in Edo



Plate 18a: Interview and questionnaire distribution during field work in Epe, Lagos State



Plate 18b: Interview and questionnaire distribution during field work in Epe, Lagos State

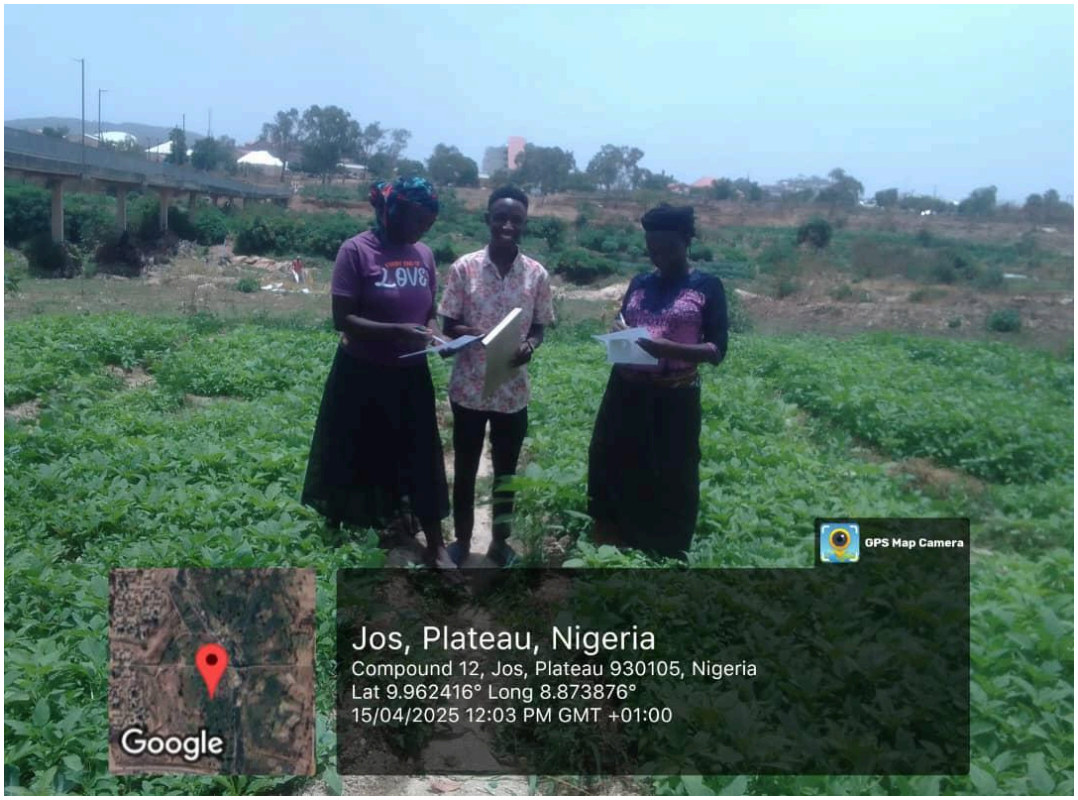


Plate 19a: Interview session with fruits/vegetation farmers in Jos, Plateau State



Plate 19b: Interview session with fruits/vegetation sellers in Jos, Plateau State

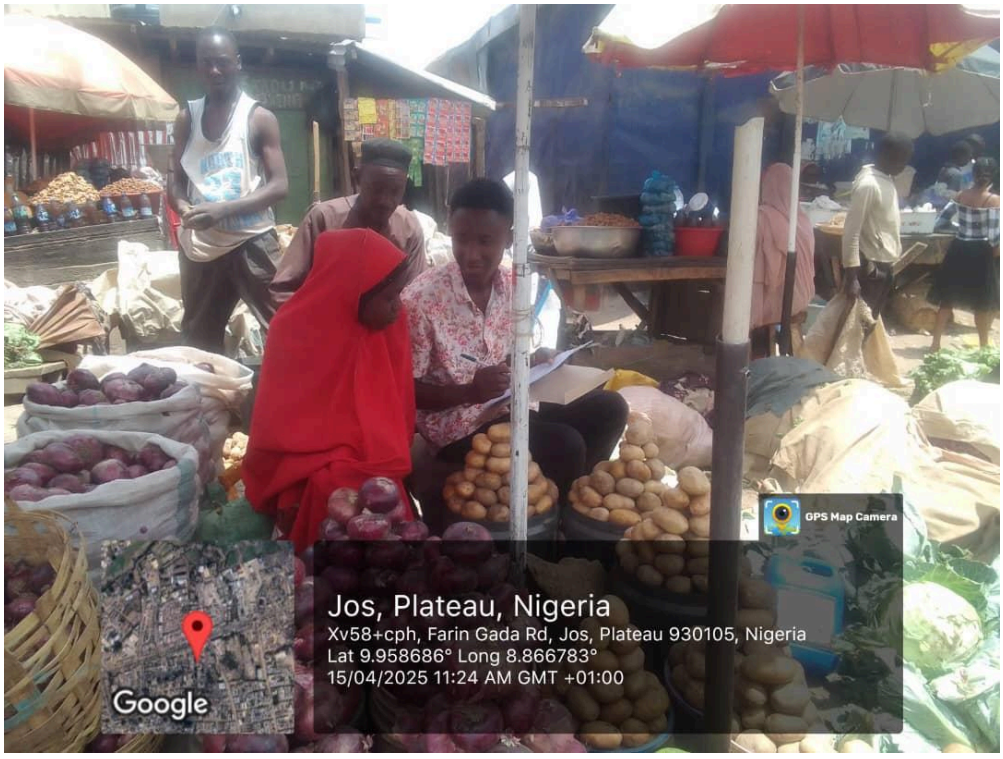


Plate 19c: Interview session with market women in Jos, Plateau State

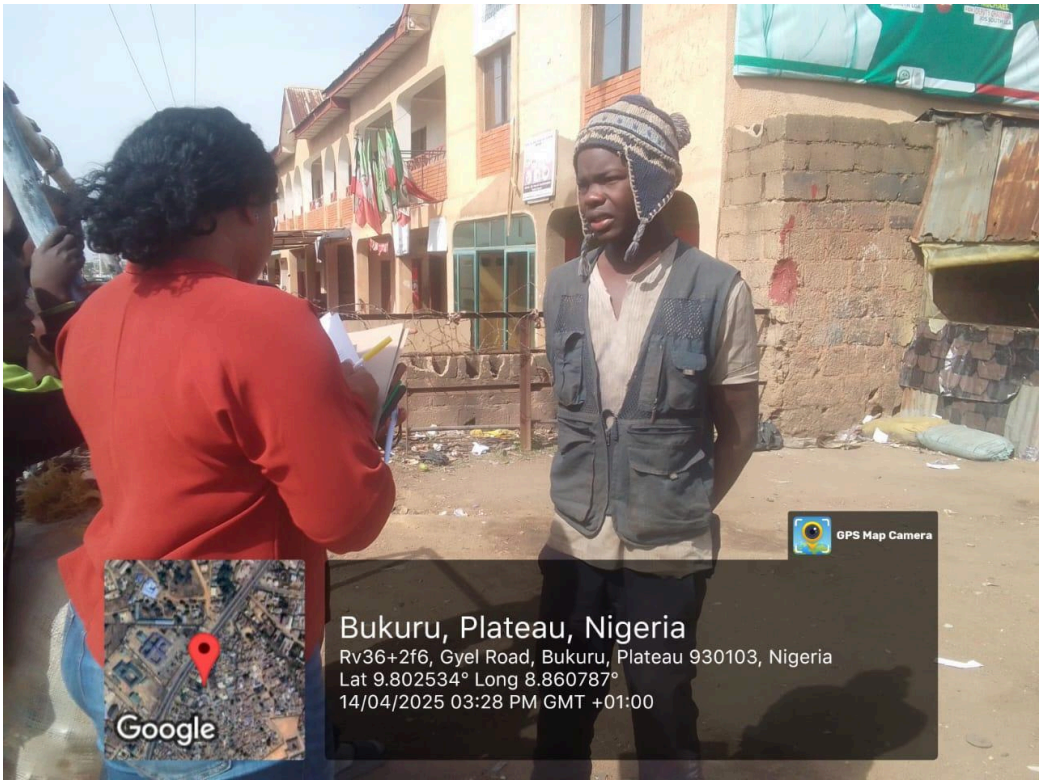


Plate 19d: Interview session with informal waste picker in Jos, Plateau State



Plate 20a: Interview session with market women in FCT, Abuja



Plate 20b: Interview session with informal waste pickers in FCT, Abuja



Plate 20c: Interview session with household in FCT, Abuja

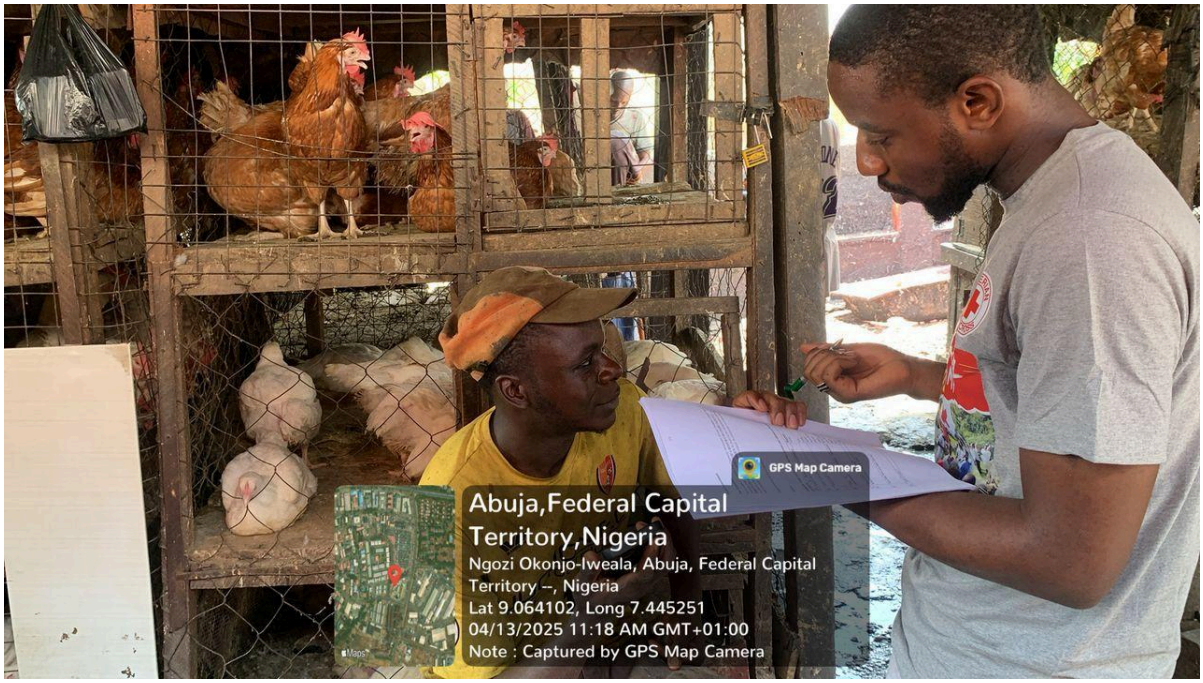


Plate 20d: Interview session with a farmer in FCT, Abuja

9.3.6. Sample Size

The sample size was determined using the formula for calculating sample size for a finite population. The formula is used when the population of study is not known (in this case, number of household, farmers, fruit sellers in each state). The formula is:

n = (Z^2 x P(1-P))/D^2

Where:

n = sample size Z = standard normal deviation at 95% confidence level (1.96) P = proportion of population estimated to have knowledge of biogas technologies (assumed to be 50%) D = margin of error (5%)

Using the formula, the sample size will be:

n = (1.96^2 x 0.5 x 0.5) / (0.05^2) n = 384

Though the calculated sample size is 384, only 125 (32.5%) of this number was sampled for the purpose this survey (i.e 125 respondents was sampled in each state and the FCT, Abuja).

9.3.7. Sampling Procedure

The study adopted both random and purposive sampling methods in the selection of respondents. McMillan and Schumacher (1997) describe purposive sampling as "selecting information-rich cases for study in-depth" when one wants to understand something about those cases without needing or desiring to generalize to all cases, in this case, fruit/food sellers and farmers. For households a random sampling process was adopted. This involved selecting every fifth house on both sides of the selected street for questionnaire administration.

9.3.8. Questionnaire Survey

This involved the use of structured questions for the purpose of gathering information on the variables under investigation. The questionnaire was administered to vegetable/fruits famers, vegetable/fruits sellers, Households and informal waste pickers. On the whole a total of one Hundred and Twenty-five (125) respondents were sampled in each location across the target population (Table 1). The questionnaire is divided into two (2) sections. Section A contains demographic information on about the respondents. Section B contain information on types of waste generated at homes/markets/collected by informal waste pickers, methods of waste handling/challenges, state of composting, use of organic and inorganic fertilizers, knowledge of composting/source of information, determinants of successful use of organic fertilizer, respondent's willingness to witch to organic fertilizer, general challenges of MSW management and peculiar challenges faced by respondents in effectively managing waste, perceived roles of authority towards a sustainable MSW management and willingness of respondents to participate in the MRF initiative.

Table 1: Indicator parameters and number of questionnaire distributed in Each State

Method	Description	Target Group	Sample Size	Purpose
Household Surveys	Structured questionnaires to assess composting adoption, waste disposal habits, and awareness levels	Households	Households, 25	To quantify waste practices and attitudes towards organic composting
Key Informant	Structured questionnaires	Farmers, Waste Pickers, Market officials and	Farmers (25), Waste Pickers (25), Market officials (25) and	To analyze policy gaps and institutional

Method	Description	Target Group	Sample Size	Purpose
Interviews (KIIs)	In-depth discussions with policy stakeholders	Environmental agencies (waste management agency)	Environmental agencies (waste management agency) (25)	barriers to waste management
Focus Group Discussions (FGDs)	Interactive sessions to explore community perspectives	Farmers, waste pickers, market leaders	3 FGDs (participants in total)	To understand cultural and socio-economic factors affecting adoption
Waste Management Facility Assessments	Site visits and observations of landfill and composting facilities	MRFs, landfill sites	Observational assessment	To assess infrastructure and waste diversion capacity
Policy and Regulatory Review	Examination of existing waste management policies	Government regulations	Document analysis	To identify policy strengths and gaps in methane reduction efforts
Environmental Assessment	Waste quantification, Estimation of methane emissions from landfill waste	Waste disposal sites	Data modeling	To establish a scientific benchmark for emissions
Total Number of Respondents per location	125 Respondents per location			

9.3.9. **Reliability and Validity of Research Instrument:**

The reliability of the research instrument eas assessed using test-retest reliability. This involved administering the questionnaire to a sample of stakeholders in waste management and operators

of dumpsites. This was done twice with a time interval of two weeks. The results were analyzed using the test-retest correlation coefficient to determine the reliability of the questionnaire. The validity of the research instrument was assessed using content validity. This involved assessing the relevance and comprehensiveness of the questionnaire by experts in the field of waste management.

9.3.10. **Ethical Considerations:**

The study followed ethical guidelines for research involving human subjects. Informed consent was obtained from the participants before administering the questionnaire. The participants were informed about the purpose of the study, their rights as participants, and the confidentiality of their responses. The data collected were kept confidential, and the participants' identities were not be revealed in any publication or report.

9.3.11. Solid Waste Characterisation

Characterisation of waste materials was done using the method described by Bernache-Perez et al. (2001), which involves the direct sampling of solid waste from specific sources, a labour-intensive manual process of sorting, classifying, and weighing all items in each sampling unit, and a detailed recording of the data. Other authors have also adopted this approach in waste characterization studies in Nigeria such as Oyelola, O. T and Babatunde (2008), Audu, et al.. (2015), Ugwu and Ozor (2020) etc. At each dumpsite, sampling points were established on the basis of accessibility (Tables 2-5 for geographical coordinates). The waste of about 25 kg, was then laid on the bare floor for sorting, weighed (net weight) with Kwonnie balance (25 kg) model TN-1741874 and sorted into categories, as recommended by the ASTM test method D5231 – 92 (1988). The total net wet weight of each waste category was determined and expressed in kilogram (kg). The process of sorting was repeated three times to arrive at mean values. Waste characterization was carried out from March - April, 2025 (Plates 21-24).

Table 2: Coordinates of sampled dumpsites in Benin City, Edo State

	Jubilant Citizen operated dumpsite		Otofure Jumpsite	
Point	Latitude	Longitude	Latitude	Longitude

A	06° 19′ 36.7”	005° 40’ 25.3”	06° 27′ 50.8”	005° 36’ 02.3”
B	06° 19′ 38.8”	005° 40’ 24.4”	06° 27′ 50.1”	005° 36’ 02.3
C	06° 19′ 35.6”	005° 40’ 25.3”	06° 27′ 49.5”	005° 36’ 01.6”
D	06° 19′ 34.7”	005° 40’ 24.9”	06° 27′ 48.0”	005° 36’ 01.2
E	06° 19′ 32.8”	005° 40’ 24.7”	06° 27′ 48.0”	005° 36’ 03.7”
F	06° 19′ 30.8”	005° 40’ 26.0”	06° 27′ 48.5	005° 36’ 02.4

Table 3: Coordinates of sampled dumpsites in Epe town, Lagos State

	Odo-Mola Iyare Rd, Epe Town		Oriyomi Aiyeola St, Epe Town		Kalejaiye Crescent, Noforija, Epe Town	
Point	Latitude	Long	Latitude	Long	Latitude	Long
A	06° 36′ 17.2”	003° 59’ 34.4”	06° 36′ 01.5”	003° 59’ 52.6”	06° 37′ 44.4”	003° 59’ 23.2”
B	06° 36′ 17.4”	003° 59’ 34.0”	06° 36′ 01.5”	003° 59’ 52.9”	06° 37′ 43.8”	003° 59’ 23.1”
C	06° 36′ 18.0”	003° 59’ 34.2”	06° 36′ 01.7”	003° 59’ 53.1”	06° 37′ 43.8”	003° 59’ 22.9”
D	06° 36′ 17.1”	003° 59’ 33.9”	06° 36′ 02.1”	003° 59’ 53.4”	06° 37′ 43.9”	003° 59’ 22.8”
E	06° 36′ 17.6”	003° 59’ 34.6”	06° 36′ 02.1”	003° 59’ 53.1”	06° 37′ 43.7”	003° 59’ 22.1”
F	06° 36′ 17.8”	003° 59’ 34.7”			06° 37′ 43.7”	003° 59’ 22.0”

Table 4: Coordinates of sampled dumpsites in Jos, Plateau State

	Federal Low Cost Area		Miango Road,		Dadin Kowa Loop,		Zamangada-Rayfield,	
Point	Latitude	Long	Latitude	Long	Latitude	Long	Latitude	Long
A	09° 52′ 45.3”	008° 51’ 03.2”	09° 51′ 46.7”	008° 51’ 56.4”	09° 51′ 22.8”	008° 51’ 57.8”	09° 50′ 49.5”	008° 52’ 27.5”
B	09° 52′ 45.2”	008° 51’ 03.3”	09° 51′ 46.7”	008° 51’ 56.4”	09° 51′ 22.8”	008° 51’ 57.7”	09° 50′ 49.5”	008° 52’ 27.4”
C	09° 52′ 45.1”	008° 51’ 03.2”	09° 51′ 46.7”	008° 51’ 56.2”	09° 51′ 22.6”	008° 51’ 57.9”	09° 50′ 49.5”	008° 52’ 27.4”
D	09° 52′ 45.2”	008° 51’ 03.2”	09° 51′ 46.7”	008° 51’ 56.0”	09° 51′ 22.7”	008° 51’ 57.8”	09° 50′ 49.5”	008° 52’ 27.3”
E	09° 52′ 45.2”	008° 51’ 03.1”	09° 51′ 46.8”	008° 51’ 56.1”	09° 51′ 22.7”	008° 51’ 57.9”	09° 50′ 49.6”	008° 52’ 27.3”
F	09° 52′ 45.3”	008° 51’ 03.1”	09° 51′ 46.7”	008° 51’ 56.2	09° 51′ 22.8”	008° 51’ 57.9”	09° 50′ 49.7”	008° 52’ 27.4”

Table 5: Coordinates of sampled dumpsites in FCT, Abuja

	Mabushi dumpsite		Obafemi Awolowo Way, Utako		Mike Akhigbe Way, Jabi		Gosa Dumpsite	
Point	Latitude	Long	Latitude	Long	Latitude	Long	Latitude	Long
A	09° 05′ 03.8”	007° 27’ 12.9”	09° 04′ 01.1”	007° 26’ 08.5”	09° 04′ 19.3”	007° 25’ 56.4”	09° 01′ 26.3”	007° 20’ 13.2”

B	09° 05′ 04.1”	007° 27’ 13.2”	09° 04′ 00.7”	007° 26’ 07.8”	09° 04′ 19.3”	007° 25’ 56.3”	09° 01′ 26.5”	007° 20’ 11.3”
C	09° 05′ 04.2”	007° 27’ 13.4”	09° 04′ 01.6”	007° 26’ 07.7”	09° 04′ 19.4”	007° 25’ 56.5”	09° 01′ 27.6”	007° 20’ 11.0”
D	09° 05′ 04.3”	007° 27’ 13.8”	09° 04′ 00.8”	007° 26’ 08.1”	09° 04′ 19.3”	007° 25’ 56.5”	09° 01′ 28.4”	007° 20’ 10.3”
E	09° 05′ 04.3”	09° 05′ 04.3”					09° 01′ 28.8”	007° 20’ 11.2”
F	09° 05′ 04.5”	007° 27’ 14.2”					09° 01′ 26.9”	007° 20’ 13.0”



Plate 21a: MSW characterization at government approved Jubilant Citizen Resources dumpsite, Benin City

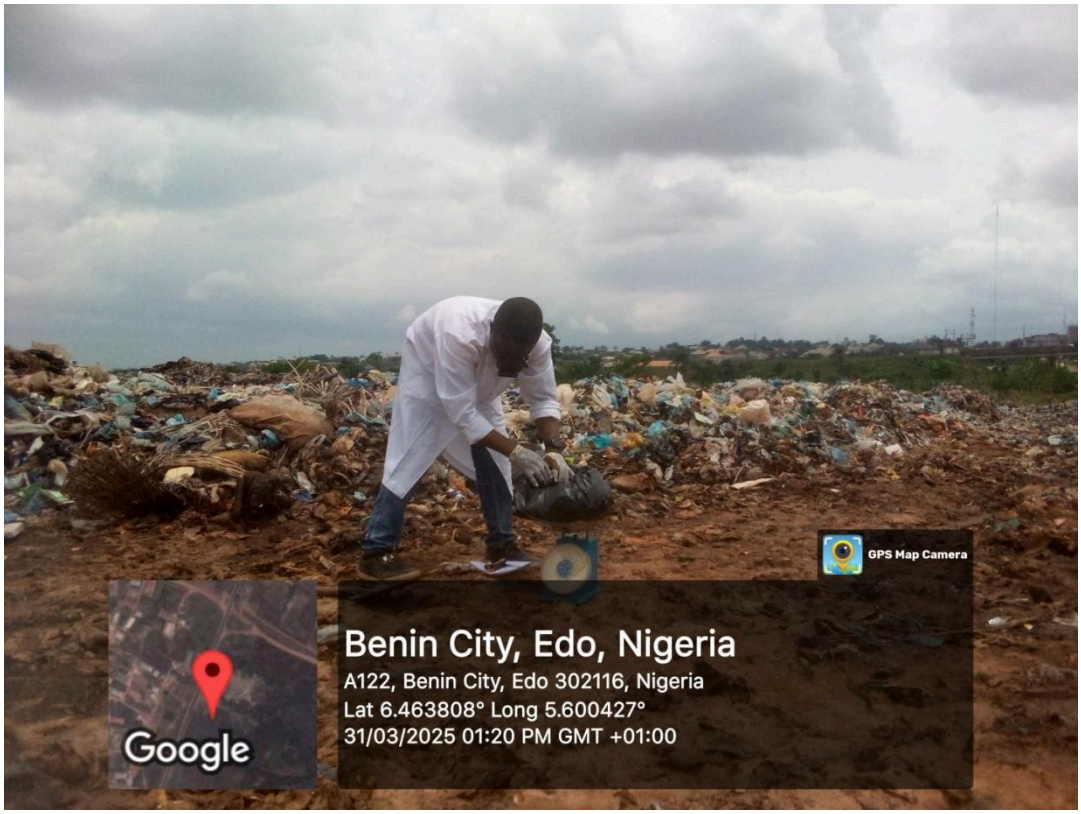


Plate 21b: MSW characterization at government approved Otofure dumpsite, Benin City

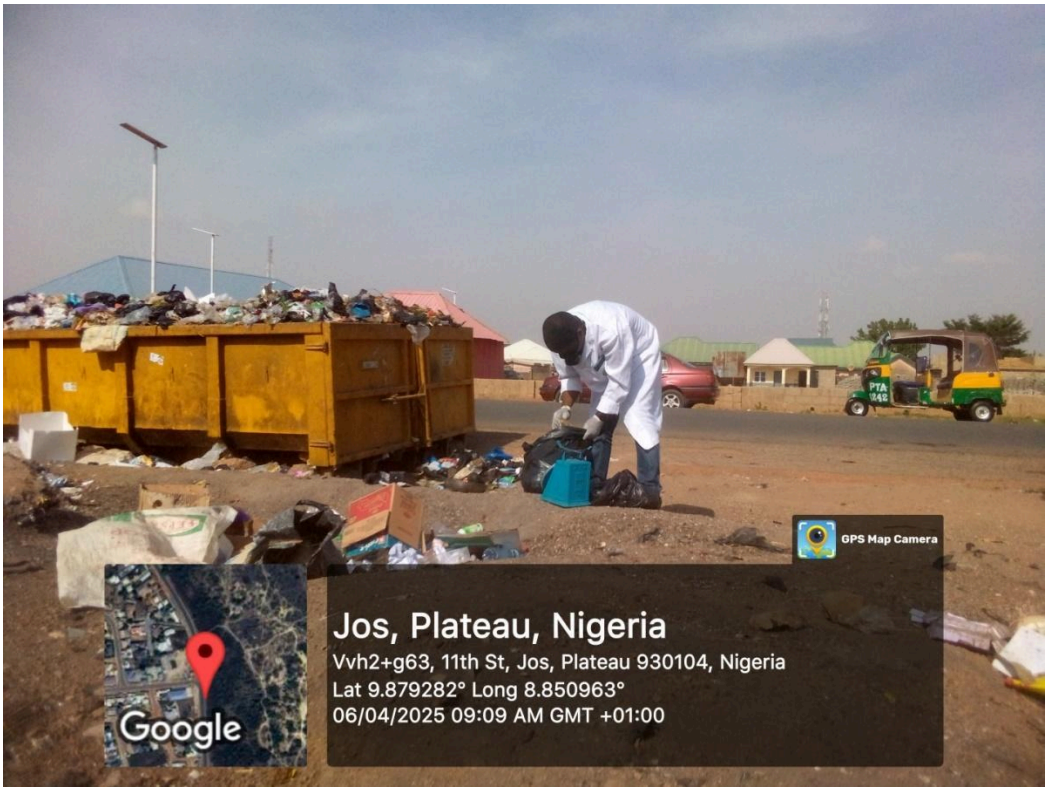


Plate 22b: MSW characterization at a designated dumpsite, 11th Street Jos, Plateau State

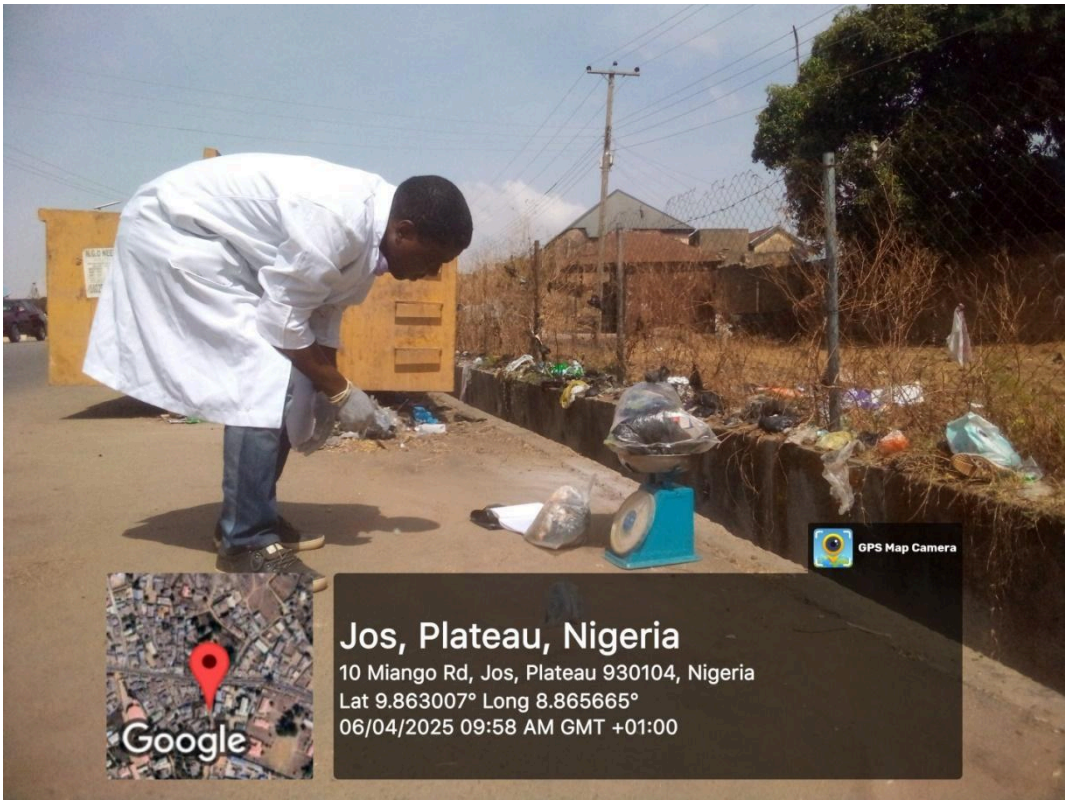


Plate 22c: MSW characterization at a designated dumpsite, Miango Rd Jos, Plateau State

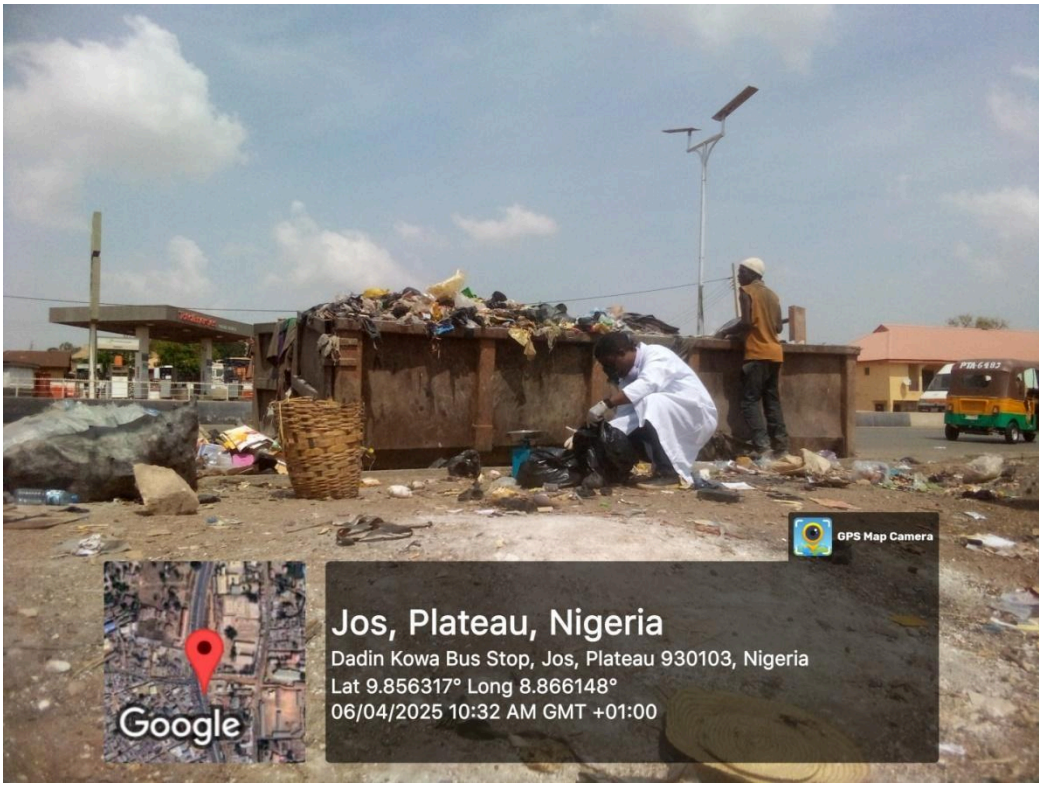


Plate 22 d: MSW characterization at a designated dumpsite, Dadin Kowa Bus stop, Jos, Plateau State

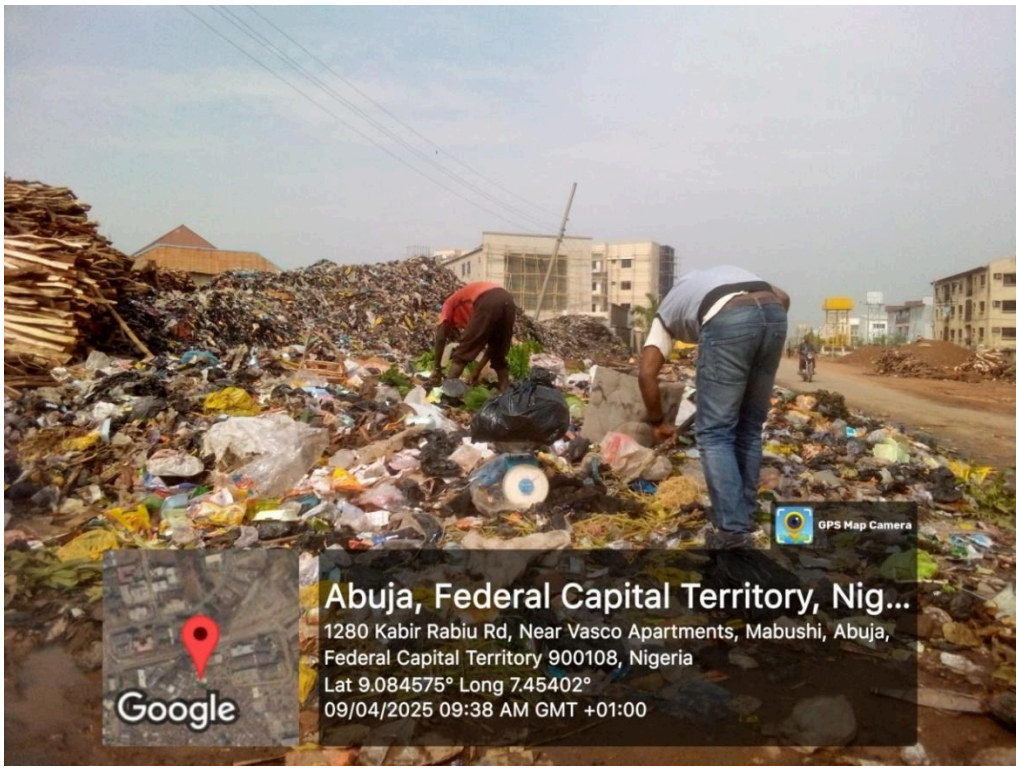


Plate 23a: MSW characterization at government approved Mabushi dumpsite, Abuja

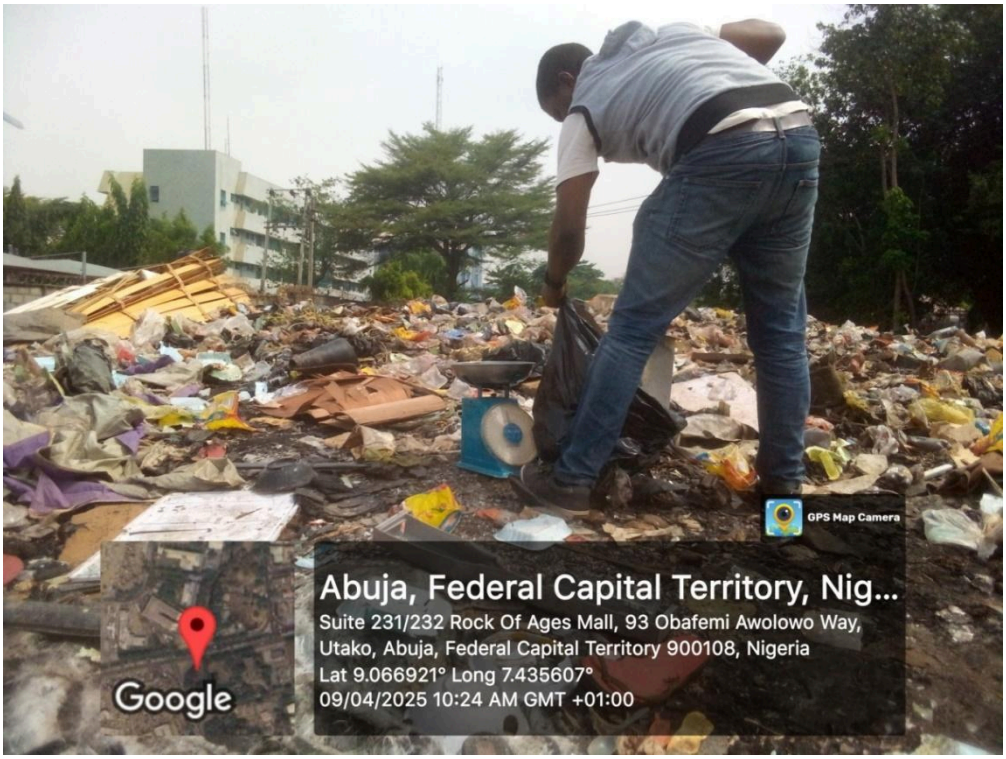


Plate 23b: MSW characterization at open/illegal dumpsite along Obafemi Awolowo Way, Utako, Abuja

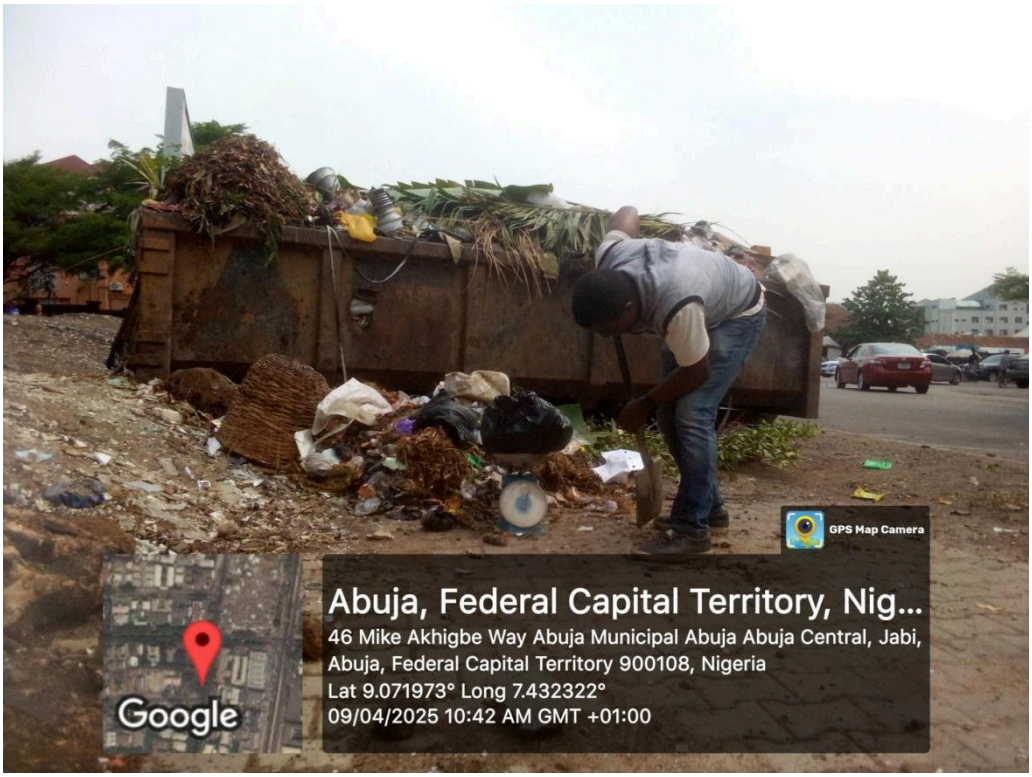


Plate 23c: MSW characterization at designated dumpsite along Akhigbe way, Jabi, Abuja

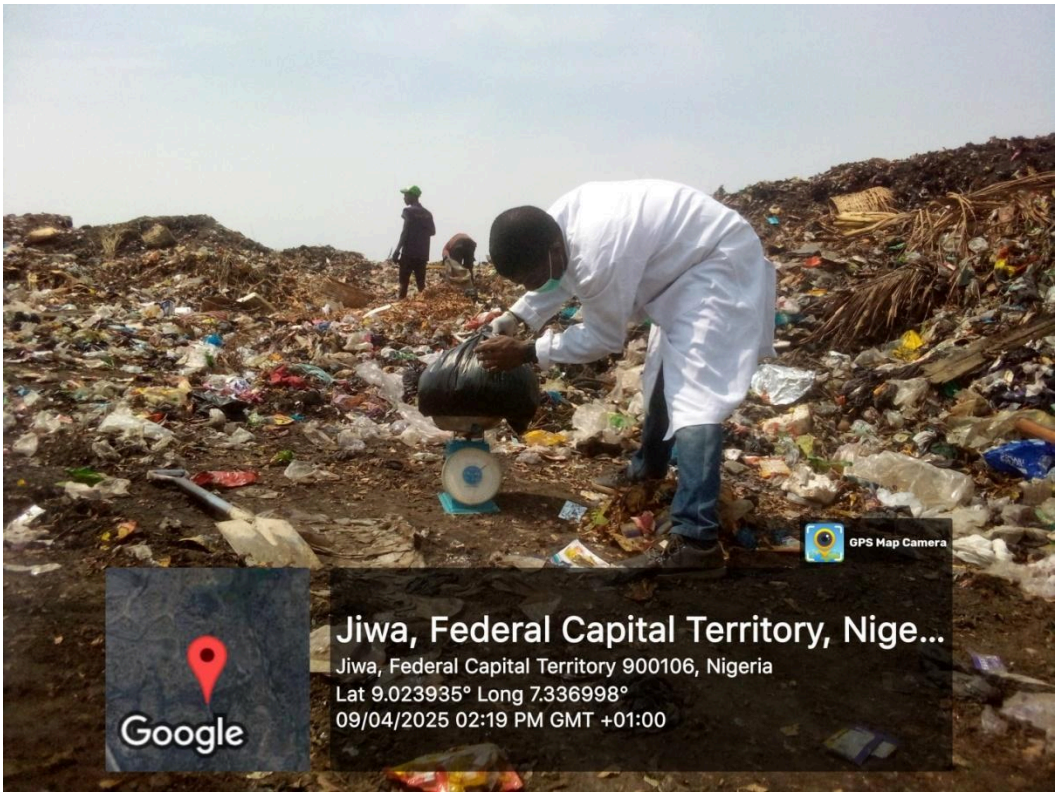


Plate 23d: MSW characterization at government approved Jiwa dumpsite, FCT, Abuja

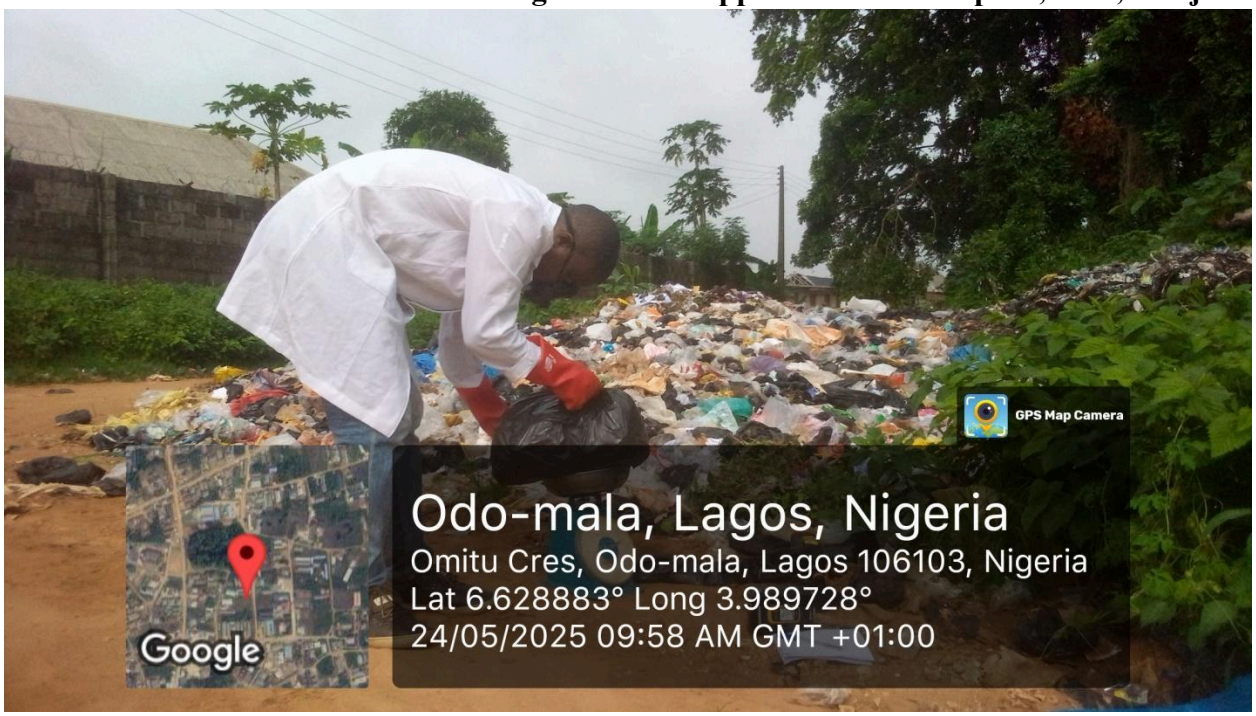


Plate 24a: MSW characterization at a Black spot, Omitu Cres, Odo-Mala, Lagos State

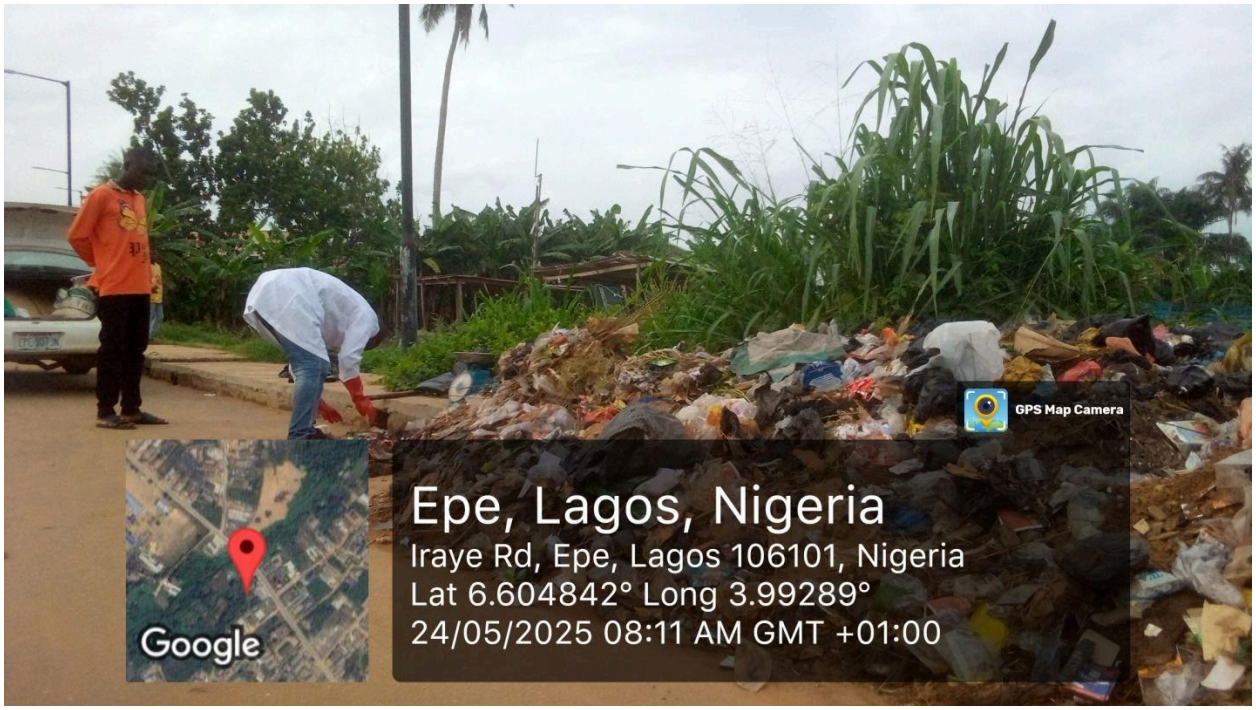


Plate 24b: MSW characterization at a Black spot, Iraye Rd, Epe, Lagos State

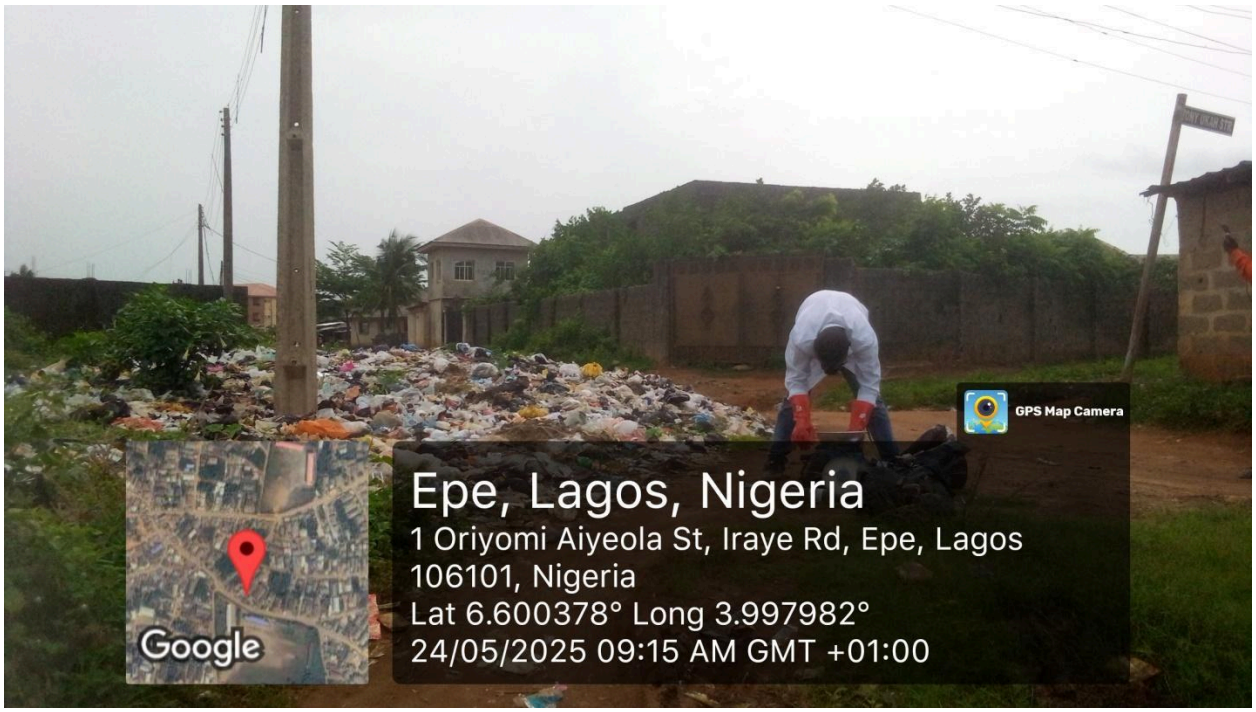


Plate 24c: MSW characterization at a Black spot, Oriyomi Aiyeola St, Iraye Rd, Epe, Lagos State

9.3.12. Mapping of Methane

The study employs Google Earth Engine (GEE) to extract methane concentration data from the Copernicus Sentinel-5P TROPOMI dataset. The dataset was filtered to cover the period from January to March 2025. This was done using the geographic information system (GIS) technique.

9.3.13. Key steps in the methodology include:

- Generation of field coordinates
- Defining the State boundary using FAO GAUL 2015 dataset.
- Mapping the waste disposal sites of interest.
- Processing Sentinel-5P TROPOMI CH4 data to derive mean and maximum methane concentration values.
- Clipping methane concentration images to State's boundary extent.
- Exporting the processed methane data for visualization and further analysis.

9.3.14. Estimation of Methane values from Dumpsites

To estimate the methane potential from dumpsites, the IPCC Zero Order Decay Model (ZODM) was used (IPCC, 1997). The Model is a quick and intuitive model that was proposed by IPCC for calculating the emission of methane from Solid Waste Disposal Sites (SWDS). The IPCC default method is a simple mass balance calculation which estimates the amount of CH_4 emitted from the SWDS assuming that all CH_4 is released the same year the waste is disposed of. More so, the Zero Order Decay Model (ZODM) is based on mass conservation technique and degradable organic carbon (DOC) of Municipal Solid Waste (MSW), with the assumption that the amount of methane generated is proportional to the entire amount of waste that has been placed in the landfills. The IPCC model is currently used in many countries all over the world to collect information for GHG annual reports because of its simple methodology and accessible structure (Delgado et al., 2023). Authors such as Abdulla and Al-Ghazzawi (2000); Kumar et al., (2004); Weitz et al., (2008); Rodrigue et al., (2018); Riman et al., (2022); Merab et al., (2025), etc. have also adopted the IPCC order decay method for estimating methane across the World. Not witstanding the wide application, some authors have reported some limitations associated with

the model. In their study, Ran-Hui et al., (2023) reported that this model can lead to considerable errors in estimating CH_4 emission because of uncertainties related to parameters (e.g., *DOC*, DOC_f, *MCF*, and *F*). For instance, *DOC* and DOC_f are dependent on waste characteristics, whereas *MCF* and *F* are affected by landfill operational conditions. To overcome this challenges, numerous studies have compared the measured CH_4 emissions of anaerobic landfills to modelled emissions to develop site-specific input model parameters (e.g., *DOC*, DOC_f, and decay rate [k]) (Govindan and Agamuthu, 2014 and Mou et al., 2015). In this study however, the determination of site-specific input model parameters such as *DOC*, DOC_f, and decay rate [k] was not carried out due to technical and financial issues relating to the availability of instruments, cost, timing and the fact that such task is labour intensive. As a results of these limitations we relied on default values which have also been used and reported for developing countries like Nigeria.

The equation is given as follows;

$$Q_{CH4} = MSW_T * MSW_F * MCF * DOC * DOC_F * F * \left(\frac{16}{12} - R\right) * (1 - OX)$$

Q_{CH4} : - Methane Emission (Gg/yr)
MSW_T: - Total MSW generated (Gg/yr)
MSW_F: - Fraction of MSW disposed to solid waste disposal sites
MCF : - Methane Correction factor (fraction)
DOC : - Degradable Organic Carbon (fraction) (kg C/kg SW)
DOC_F : - Fraction DOC dissimilated
F: - Fraction of CH4 in landfill gas (IPCC default is 0.5)
$\frac{16}{12}$: - conversion of C to CH4
R : - recovered CH_4 (Gg/yr)
OX: - oxidation factor (fraction – IPCC default is 0)

9.3.14.1. Computation of Methane emission from dumpsites in Benin City, Edo State

= Total amount of Waste generated for a particular year

Two sites were sampled in Benin City, Edo State; Jubilant Solid Waste Disposal Site located in Ikpoba-Okha Local Government and Otofure Solid Waste Disposal Site in Ovia North-East Local Government, both of Edo State.

According to the population census record of 2006, **Ikpoba-Okha** and **Ovia North-East** had **372,080** and **155,344** as population respectively. Also, by extrapolation the values using the annual population growth rate factor for Edo State **(0.32%)**, the populations become **676,940** and **282,623** for Ikpoba-Okha and Ovia North-East respectively as at 2025.

With the above population, the Total Municipal Solid Waste (MSW_T) generated will be;

$$MSW_T = Waste\ Generation\ Rate \times Population \times 365$$

For Jubilant SWDS

$$= 0.55 \times 676,940 \times 365$$

$$= 135,895,705\ Kg/Annum$$

$$= 135,896\ Tonnes/Annum$$

For Otofure SWDS

$$= 0.53 \times 282,623 \times 365$$

$$= 54,673,419.35\ Kg/Annum$$

$$= 54,673\ Tonnes/Annum$$

Fraction of Municipal Solid Waste that gets to the Landfill Site (MSW_F)

Literatures showed that for developing countries, the value adopted for the fraction of the municipal solid waste that gets to the Landfill is $0.74\ as\ suggested\ by$ (Ogunjuyigbe et al., 2017)

Methane Correction Factor (Fraction) – MCF

Three default values ranging from 1.0 to 0.4 are usually used, depending on the site management and with 0.6 as general default value (Johari *et al.* 2012).

Degradable Organic Carbon (Fraction)

This value varies from City to City because it is dependent on the prevalent activity of the said city.

DOC is estimated using;

$$DOC = 0.40A + 0.17B + 0.15C + 0.30D$$

Where;
A = Paper and rags; B = Leaves + hay + Straws; C = Fruits and Vegetables; and

D = Wood.

The percentage composition of the respective waste types was substituted in the above equation and the respective DOC value for the sample points are presented in the result section.

Fraction DOC dissimilated (DOC_F)

DOC_F is estimated theoretically with the equation;

$$DOC_F = 0.014T + 0.28$$

Where;

T is the Temperature at the anaerobic region of the Landfill where methane is produced down the Landfill. The default value is **0.77** as suggested at T = 50^0C by Bingemer and crutzen (1987).

Fraction of CH4 in Landfill gas (F)

The default suggested by IPCC is **0.5**

Conversion Factor (C to CH_4)

Where;

R is usually taken as zero, since there was no record of recovery

$$\frac{16}{12} - R = 1.333 - 0$$

$$= 1.333$$

Oxidation Factor

This is usually taken as zero.

Inputting the values of the parameters from A to H, the emission quantity was then estimated (Methane values are presented in result section of this report)

9.3.14.2. Computation of Methane emission from dumpsites in Jos, Plateau State

MSW_T **= Total amount of Waste generated for a particular year**

Four sites were investigated for methane emission in Jos Plateau State such as Low Cost Area and Miango Road Collection Buckets (Jos North LGA), and Dadin-kowa Road and Zamangada-Rayfield (Jos South LGA). By the census record of 2006, **Jos North** and **Jos South** had **437,217** and **311,392** as population respectively. These values were extrapolated to 2025,

using an annual population growth rate factor of 3.4%, to **825,253** and **587,756** for Jos North and Jos South respectively.

With the above population, the Total Municipal Solid Waste (MSW_T) generated was then;

$$MSW_T = Waste\ Generation\ Rate \times Population \times 365$$

For Jos North SWDS

$$= 0.58 \times 825,253 \times 365$$

$$= 174,706,060\ Kg/Annum$$

$$= 174,706\ Tonnes/Annum$$

For Jos South SWDS

$$= 0.56 \times 587,756 \times 365$$

$$= 120,137,326\ Kg/Annum$$

$$= 120,137\ Tonnes/Annum$$

Fraction of Municipal Solid Waste that gets to the Landfill Site (MSW_F)

Literatures showed that for developing countries, the value adopted for the fraction of the municipal solid waste that gets to the Landfill is 0.74.

Methane Correction Factor (Fraction) – MCF

Three default values ranging from 1.0 to 0.4 are usually used, depending on the site management and with 0.6 as general default value. So, 0.6 it is.

Degradable Organic Carbon (Fraction)

This value varies from City to City because it is dependent on the prevalent activity of the said city.

DOC is estimated using;

$$DOC = 0.40A + 0.17B + 0.15C + 0.30D$$

Where;

A = Paper and rags; B = Leaves + hay + Straws; C = Fruits and Vegetables; and

D = Wood.

The percentage composition of the respective waste types was substituted in the above equation and the respective DOC value for the sample points are presented in the result section of this report.

Fraction DOC dissimilated (DOC_F)

DOC_F is estimated theoretically with the equation;

$$DOC_F = 0.014T + 0.28$$

Where;

T is the Temperature at the anaerobic region of the Landfill where methane is produced down the Landfill. The default value is **0.77** as suggested at T = 50^0C by Bingemer and crutzen (1987).

Fraction of CH4 in Landfill gas (F)

The default suggested by IPCC is **0.5**

Conversion Factor (C to CH_4)

Where R is usually taken as zero, since there was no record of recovery

$$\frac{16}{12} - R = 1.333 - 0$$

$$= 1.333$$

Oxidation Factor

This is usually taken as zero.

Inputting the values of the parameters from A to H, the emission quantity was then estimated as shown in the result section of this report;

9.3.14.3. Computation of Methane emission from dumpsites FCT, Abuja

MSW_T = Total amount of Waste generated for a particular year

Four sites were sampled in the FCT, Abuja such as Mabushi, Utako, Jabi and Gosa Solid Waste Disposal Sites, all located in the Abuja Metropolis Area Council (AMAC), FCT Abuja.

The population census record of AMAC by 2006, was **778,567** and was projected to be **1,693,400** in the year 2022. However, for the purpose of this study, the population value was

further projected to 2025, using a annual population growth rate factor for AMAC, FCT of **5%**. Hence, we arrived at **1,960,322** as the projected figure for the year 2025.

With the above population, the Total Municipal Solid Waste (MSW_T) generated will be;

$MSW_T = Waste\ Generation\ Rate \times Population \times 365$

For Mabushi SWDS

$= 0.65 \times 1,960,322 \times 365$

$= 465,086,394.5\ Kg/Annum$

$= 465,086\ Tonnes/Annum$

Note: All the sampled Dumpsites fall in the same Area Council, so the same Waste Generation Rate applies.

Fraction of Municipal Solid Waste that gets to the Landfill Site (MSW_F)

Literatures showed that for developing countries, the value adopted for the fraction of the municipal solid waste that gets to the Landfill is 0.74.

Methane Correction Factor (Fraction) – MCF

Three default values ranging from 1.0 to 0.4 are usually used, depending on the site management and with 0.6 as general default value. So, 0.6 it is.

Degradable Organic Carbon (Fraction)

This value varies from City to City because it is dependent on the prevalent activity of the said city.

DOC is estimated using;

$DOC = 0.40A + 0.17B + 0.15C + 0.30D$

Where;
A = Paper and rags; B = Leaves + hay + Straws; C = Fruits and Vegetables; and
D = Wood.

The percentage composition of the respective waste types was substituted in the above equation and the respective DOC value for the sample points are presented in the result section of this report.

Fraction DOC dissimilated (DOC_F)

DOC_F is estimated theoretically with the equation;

$$DOC_F = 0.014T + 0.28$$

Where;

T is the Temperature at the anaerobic region of the Landfill where methane is produced down the Landfill. The default value is **0.77** as suggested at T = 50^0C by Bingemer and crutzen (1987).

Fraction of CH4 in Landfill gas (F)

The default suggested by IPCC is **0.5**

Conversion Factor (C to CH_4)

Where R is usually taken as zero, since there was no record of recovery,

$$\frac{16}{12} - R = 1.333 - 0$$

$$= 1.333$$

Oxidation Factor

This is usually taken as zero.

Inputting the values of the parameters from A to H, the emission quantity can be estimated as shown in the results section of this report;

9.3.14.4. Computation of Methane emission from dumpsites in Epe Town, Lagos State

MSW_T **= Total amount of Waste generated for a particular year**

Three sites were visited for Solid Waste Characterization exercise in Epe Local Government of Lagos, and they are considered blackspots. These are Odo Mola Iraye Road; Oriyomi Aiyeola Street; Kalejaiye Noforija Area, all of Epe Local Government, Lagos.

The population of Epe from 2006 population census was **323, 534** and if extrapolated using the Annual Population Growth Rate of **3.70%** for Lagos, the Population for Epe would become **645,432** in the year 2025.

With the above population, the Total Municipal Solid Waste (MSW_T) generated will be;

$$MSW_T = Waste\ Generation\ Rate \times Population \times 365$$

$$= 0.66 \times 645,432 \times 365$$

$= 155,484,568.8\ kg/Annum$

$= 155,485\ Tonnes/Annum$

Note: All the sampled Dumpsites fall in the same Local Government, so the same Waste Generation Rate applies.

Fraction of Municipal Solid Waste that gets to the Landfill Site (MSW_F)

Literatures showed that for developing countries, the value adopted for the fraction of the municipal solid waste that gets to the Landfill is 0.74.

Methane Correction Factor (Fraction) – MCF

Three default values ranging from 1.0 to 0.4 are usually used, depending on the site management and with 0.6 as general default value. So, 0.6 it is.

Degradable Organic Carbon (Fraction)

This value varies from City to City because it is dependent on the prevalent activity of the said city.

DOC is estimated using;

$DOC = 0.40A + 0.17B + 0.15C + 0.30D$

Where;

A = Paper and rags

B = Leaves + hay + Straws

C = Fruits and Vegetables

D = Wood

The percentage composition of the respective waste types was substituted in the above equation and the respective DOC value for the sample points are presented in the value table.

Fraction DOC dissimilated (DOC_F)

DOC_F is estimated theoretically with the equation;

$DOC_F = 0.014T + 0.28$

Where;

T is the Temperature at the anaerobic region of the Landfill where methane is produced down the Landfill. The default value is **0.77** as suggested at T = 50^0C by Bingemer and crutzen (1987).

Fraction of CH4 in Landfill gas (F)

The default suggested by IPCC is **0.5**

Conversion Factor (C to CH_4)

Where R is usually taken as zero, since there was no record of recovery

$\frac{16}{12} - R = 1.333 - 0$

$= 1.333$

Oxidation Factor

This is usually taken as zero.

Inputting the values of the parameters from A to H, the emission quantity can be estimated as shown in the results section of this report;

10. CURRENT WASTE MANAGEMENT STRUCTURES IN NIGERIA:

10.1. Situation in Benin Edo State

Municipal solid waste management in Edo state is supervised by the Edo state waste management Board (ESWMB), an agencies under the State Ministry of Environment and Public Utilities. The Edo State Waste Management Board is committed to creating a sustainable waste management system through responsible resource utilisation, waste reduction, reuse, and recycling initiatives. Ensure efficient and effective waste collection services throughout Edo State. The Edo State Waste Management Board is the driving force behind a clean, healthy, and sustainable environment for the people of Edo. It is also committed to implementing innovative waste collection, disposal, and resource recovery solutions that promote well-being and a thriving economy. ESWMB has four (4) key objectives; namely,

1) Ensure efficient and effective waste collection services throughout Edo State
2) Maximise resource recovery from waste streams, turning waste into valuable products or energy.
3) Protect public health by implementing safe and environmentally sound waste disposal practices
4) Continuously improve our operations through research, innovation, and the adoption of best practices.

The setup of ESWMB dates back to the Edo State Environmental and Waste Management Board, established in 2000. Today, the Board operate under the guidance of the Edo State Sanitation and Pollution Management Law No. 5 of 2010.

ESWMB Key Functions

Through the office of Service Project Clean-Up Edo (PCUE), ESWMB carries out the following key functions aimed at driving Environmental Excellence across the state. PCUE is a multifaceted initiative designed to transform waste management across Edo State. Key components include

Licensing of Private Recycling Facilities PCUE streamlines the process of establishing private recycling facilities across the state. This encourages investment in the sector, expanding waste processing capabilities and promoting a circular economy where resources are recovered and reused.

State-of-the-Art Waste Treatment Facility This flagship project involves developing a centralised, modern waste treatment facility in Benin City. It will employ advanced technologies to maximise resource recovery, minimise waste sent to landfills, and safeguard the environment.

Mini Litter Bins for Motorists PCUE promotes individual responsibility by providing mini litter bins to motorists. This simple initiative helps prevent litter on our roads and encourages a culture of environmental stewardship.

Expanded Waste Management Coverage PCUE extends waste collection and management services to underserved areas of the state. This ensures equitable access to a clean environment and improves public health outcomes for all Edo State residents.

Regional Waste Management Offices establishing regional offices strengthens PCUE's coordination and reach. These offices provide localized waste management solutions, tailored to the specific needs and resources of different regions.

ESWMB Operational structure

To effectively pursue its mandate, ESWMB has five (5) departments with specific responsibilities such as;

Waste Collection and Transportation Department (WCTD): oversees the efficient and organized collection of waste from residential and commercial areas throughout Edo State.

Key Responsibilities of WCTD,

- Developing and implementing waste collection routes: Ensuring all areas are serviced and optimising collection schedules.
- Managing waste collection contracts: Collaborating with private waste collection companies to ensure adherence to standards and service agreements.
- Monitoring collection performance: Tracking collection rates, identifying problem areas, and implementing improvements.
- Public education on waste collection procedures: Informing residents and businesses about sorting guidelines, collection schedules, and proper waste storage practices.

Waste Processing and Disposal Department (WPDD): manages the transformation of collected waste into reusable materials or safe disposal.

Key Responsibilities of (WPDD)

- Overseeing waste processing facilities: Ensuring efficient operation of recycling plants, composting facilities, or other waste treatment centers.
- Implementing waste diversion strategies: Maximizing recycling and composting rates to reduce the amount of waste going to landfills.
- Managing landfills: Ensuring safe and environmentally compliant disposal of waste that cannot be recycled or composted.
- Monitoring and regulating waste processing facilities: Enforcing environmental regulations and safety standards at all processing facilities.

Public Education and Awareness Department (PEAD): focuses on promoting public understanding and participation in effective waste management practices.

Key Responsibilities OF PEAD

- Developing public awareness campaigns: Educating residents and businesses about waste reduction, sorting, recycling, and responsible disposal practices.

- Community outreach programs: Organising workshops, campaigns, and events to engage the public in waste management solutions.
- Collaborating with schools and community organisations: Integrating waste management education into school curricula and community programs.
- Public communication and media relations: Disseminating information about waste management initiatives and services offered by the ESWMB.

Enforcement and Monitoring Department (EMD): ensures compliance with waste management regulations and promotes responsible waste disposal practices.

Key Responsibilities OF EMD

- Developing and enforcing waste management regulations: Establishing guidelines for waste handling, storage, and disposal for all sectors.
- Conducting inspections: Monitoring waste management practices at residential and commercial facilities to identify and address non-compliance issues.
- Implementing enforcement measures: Issuing warnings or fines to those who violate waste management regulations.
- Data collection and analysis: Tracking waste generation data and monitoring the effectiveness of enforcement actions.

Planning and Research Department (PRD): focuses on long-term planning, research, and development of innovative waste management solutions.

Key Responsibilities OF PRD

- Researching and developing new technologies: Identifying and evaluating emerging technologies for waste reduction, recycling, and disposal.
- Planning for future waste management needs: Projecting future waste generation trends and developing strategies to meet growing demands.
- Data analysis and reporting: Collecting and analysing data on waste generation, disposal practices, and recycling rates to inform planning and decision-making.
- Collaborating with research institutions and the private sector: Partnering with external entities to explore sustainable waste management solutions.

Solid Waste Services in Benin City

Benin City has witnessed tremendous increase in population and urban expansion over the years. According to 2006 census, the population of Benin City was 1,085,892 with a growth rate of 2.8 percent (National Population Commission, 2010). According to the Nigeria Population Commission projected population figures for the 2022, Benin City population at a growth rate of 3.31% is 1,841,000 (National Bureau of Statistics, 2023). With rapid population growth and soaring urbanization, the city is grappling with increased wastes generation and the need for improved waste management. Available studies show that Benin City generates 573.6 tons of MSW daily—20% from plastic waste packed from hotels, restaurants, ceremonial venues, and public service centers, 50% from mixtures of organic and inorganic waste from urban and industry, and 30% from residential homes and public places (Oseghale 2011; Ezeudu, and Ezeudu, 2019). As a result of the growing pressure on public infrastructure the State Government resorted to involving the private sector in the provision of municipal waste services. The Local Government authorities initially engaged the services of private operators to undertake the collection and disposal of solid wastes in government-approved dumpsites. At first, this process was successful and led to an improvement in waste services. However, by 1994, some private operators engaged in house-to-house refuse collection had withdrawn their services because of a rise in operating costs, including vehicle maintenance. Against this background of the State government's inability to cope with refuse services, in 1995, the State government adopted the contracting method of private sector participation for all parts of the State; this was tagged the "commercialization" of waste services. The 2 tenure of Adams Oshiomole in 2015 introduced some proactive changes and measures on sanitation drive and measures at strategy areas (markets, medicals, institutions, and households) in Benin City metropolis on the menace of waste management. These constituted government agencies such as; Edo State Waste Management Board (ESWMB), Operation Clean-up Edo State (OCES), and Special Environmental Task Force (SETF), were set up in 2015 and saddled with the mandates and responsibilities to improves sanitary conditions of the State metropolitan areas from the menace of poor waste management. In addition to this constitution of government agencies, the administration of Adams Oshiomole gave rooms to private-partnership-operators such as; Private Sector Practitioners (PSP) and Environmental Free-Lancers (EFL) to partners with the State and Local authorities for enhancement of waste management, enforcement, and sanction of offenders

in line with the provision and appropriate Sections of the 1999 Constitutions of the Federal Republic of Nigeria in matters of environmental management and sanitary issues.

Responsibility of State and Local Government Councils Area MSWM

Solid waste management in Benin City is managed by three (3) tripartite bodies. These are

a) Local Government Area Councils
b) Private Sector Practitioners and,
c) Environmental Free-Lancers (ESWMB; Archival, 2017; 2018; Agbebaku, 2018).

State and Local Government councils: Local government councils take charges of waste management within their council areas as constitutionally agreed with the State Government and at Local Government councils area waste management is done via the unit and subunits of Environmental Protection and Safety (EPS), such as; (a) Waste Managers and Utility Services (b) Environmental Health and (c) Volunteers "Task Force". These units were established with the sole mandate to adequately manage waste materials and ensure the environmental quality of the components of the environment within the council areas of jurisdiction. The sole responsibility of State, Local and Corporate agencies were to ensure the; (a) provision of land for siting of waste management infrastructure (b) supervision of the enforcement of waste management by-law enacted by Local Government (c) imposition of waste recycling on manufacturing industries (d) provision of assistance in capacity building and (e) empowered sanitary inspectors to enforce all aspect of sanitary by-law (Ogu, 2000; Monday and Danieles, 2011; ESWMB, Archival, 2017, 2018). The State and Local Government agencies ensure and enforce adequate sanitary regulations and laws on anticipatory, regulatory, and continuous controls on waste matters on the environment. Local Government area through the units, provide measures and stimulate residents to ensure adequate clean-up of their surroundings, areas of jurisdiction and ensure prompt service providers, compliance to service operations, sanctions, and enforcement of environmental laws (Monday and Danieles, 2011; ESWMB, Archival, 2017, 2018; Agbebaku, 2018). The department of sanitation and safety services monitors and oversee the activities of accredited and registered private waste managers whereas, nothing is done of environmental-free-lancers because their activities are not coordinated. This is owed to the fact that their services were open to those who have the strength to drive the wheels for sustainability (Agbebaku, 2022). Finally, the Edo State Waste Management Board appoints, regulates, and monitored the activities and

services of the private sector managers of the State and Local Government Areas in the City of Benin.

Private Sector Practitioners

The private sector practitioners are the accredited and registered waste managers approved by Edo State Waste Management Board (ESWMB). The Board monitors regulate and appoint waste service operators' through the Sanitation and Safety Services department. This service operative operates within their areas of approved coverage and jurisdiction on mutual agreement with the Board. These operatives have a sharing formula on a monthly or yearly basis with the Board (ESWMB/Archival, 2018). Within the coverage area, residents provide waste bins and drop their waste for collection by private collectors/operators (Plates 25a and b). Payments for services are usually done by month ending, through the bank and directly to these service operators. The activities of private sector practitioners are controlled by staff of the Local Government council's area through a department of the State Government (ESWMB/Archival, 2018). According to Ogu (2000) and Monday and Danieles (2011), private waste managers were created to be assigned to delineated quarters and cells in their areas of coverage and mandated to ensure effective management of the menace of indiscriminate dumps of waste materials within their jurisdiction. Cross-carpeting by service operators for waste collection is not maintained and erring violators are sanctioned by the Board. These measures are part of the condition for requirements and appointment of service operators into the business of waste management.

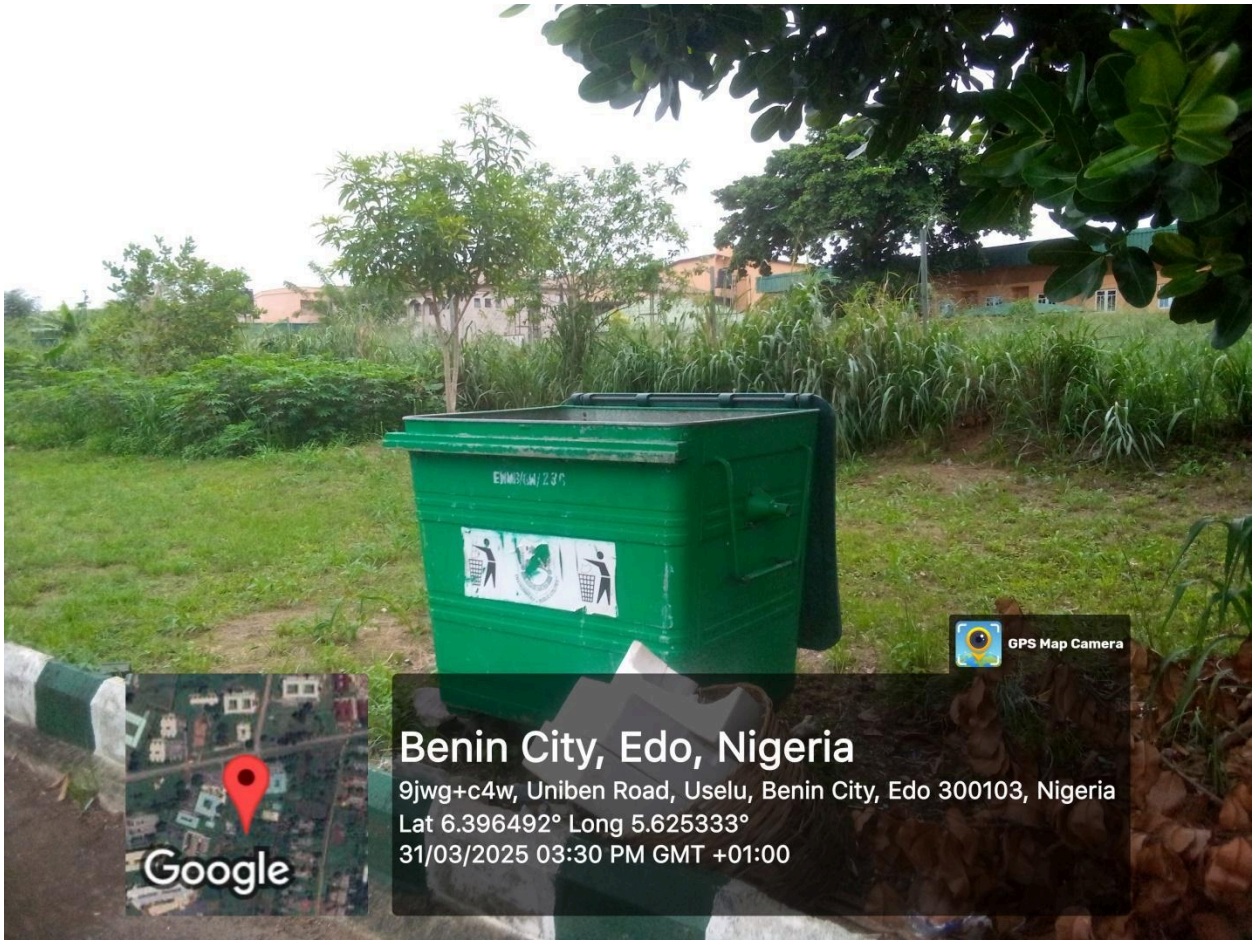


Plate 25a: privately provided waste bin to aid waste collection by licensed MSW collectors

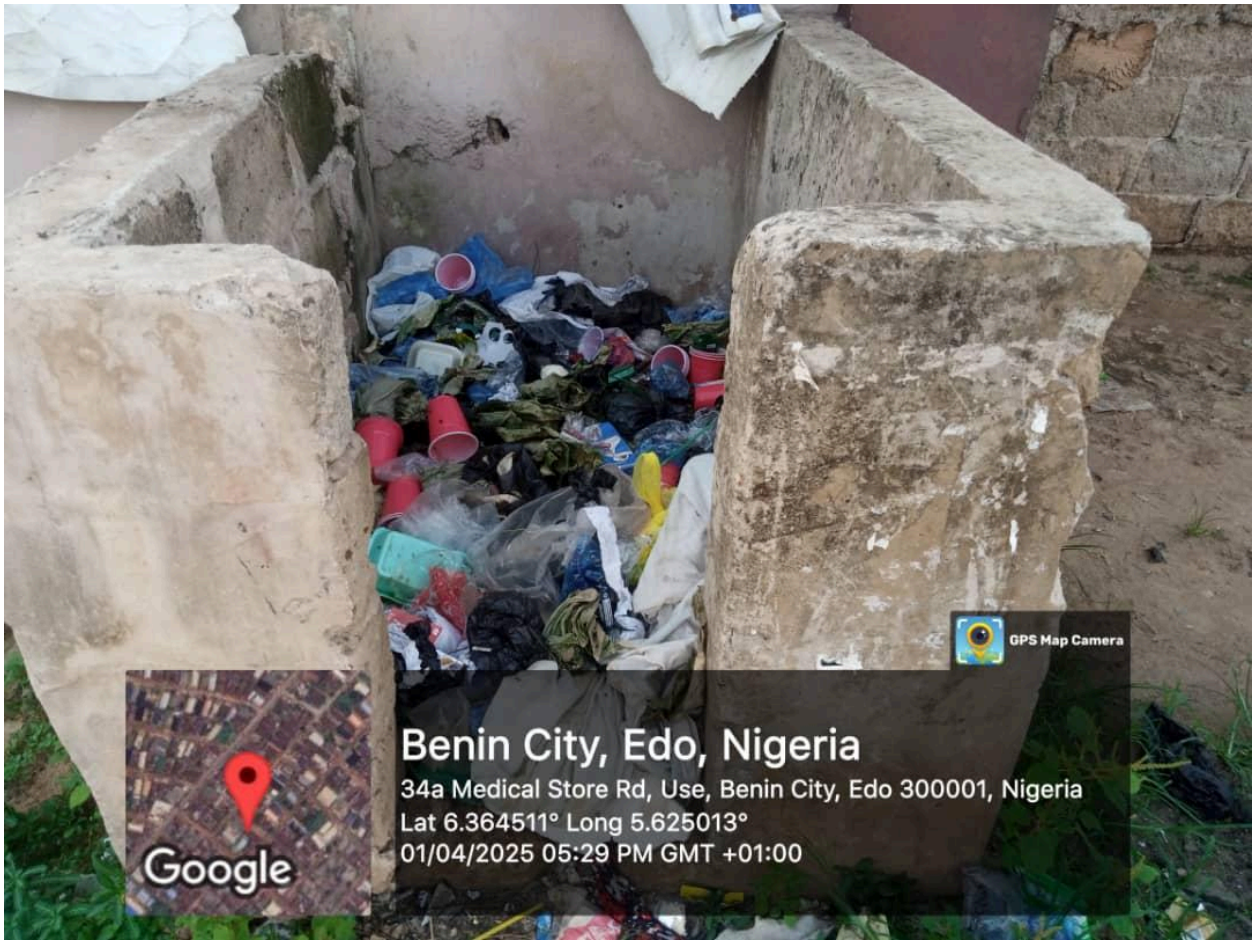


Plate 25b: Improvised waste bin to aid waste collection by licensed MSW collectors

Private Sector Waste Transportation in Benin City

Evacuation of waste materials by service operators is mainly done through road transport; via the use of heavy- duty vehicles, open trucks, wheelbarrow, van, and tricycle, and head portage by waste vendors from interior and in-accessible areas to government approved dumpsites or privately operated dumpsites (with government approval) (Plates 26 and 27). As recommended by the Board, registered private sector practitioners should have at least one environmental health officer to enhance the safety of humans and the environmental quality of the environment. The use of compactor trucks as recommended by WHO served as the benchmark for appointment of service operators into the scheme; except for exceptional cases where such vehicles cannot thrive in such areas owning to the inaccessibility of the road network in some areas (Monday and Danieles, 2011).



Plate 26: Private Dumpsite operated by Jubilant Citizen Resources LTd dumpsite in Benin City (with government approval)

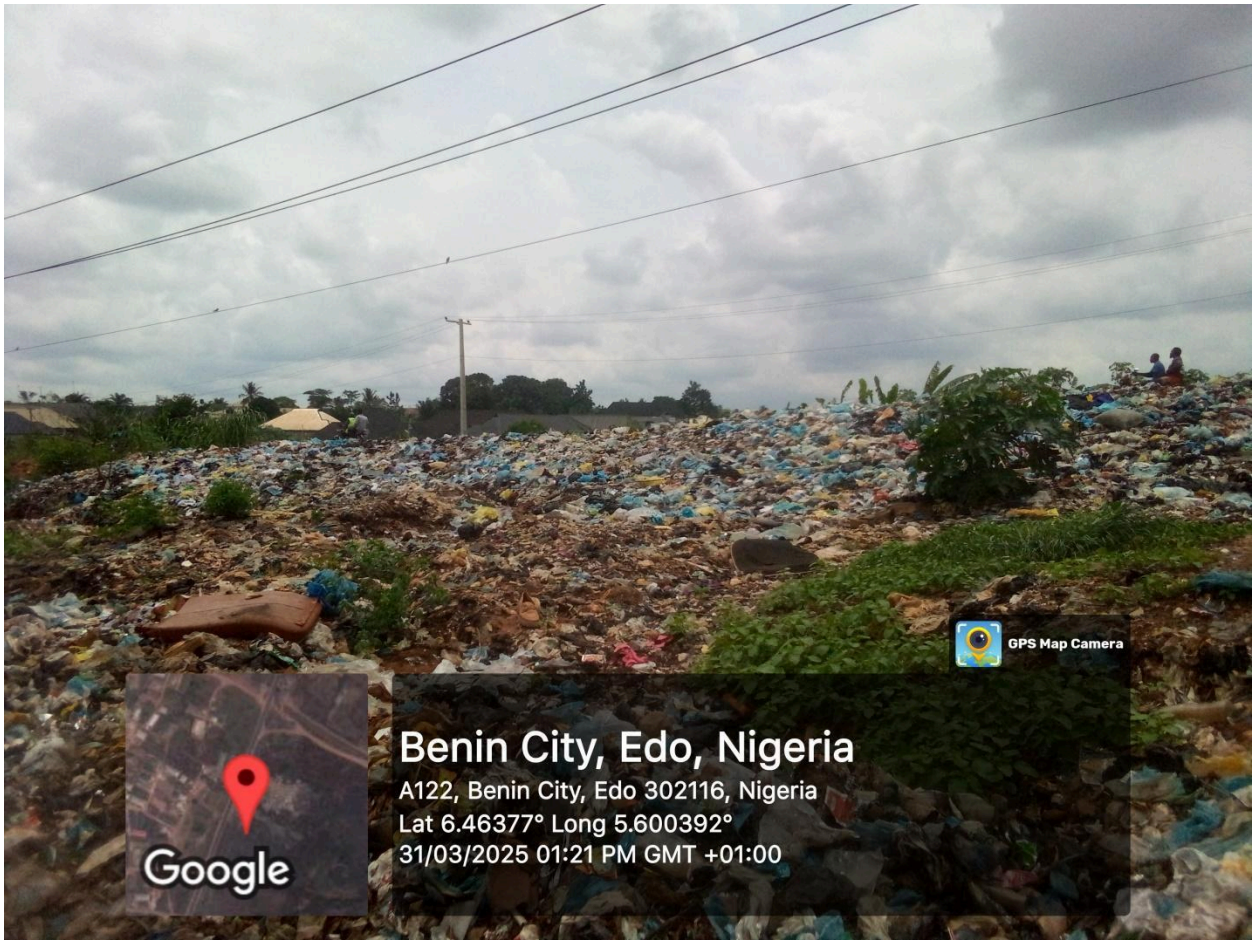


Plate 27: Government operated/approved Otofure dumpsite in Benin City, Edo State

Environmental Free-Lancers in Benin City

The Environmental Free-Lancers are also known as waste vendors, and their activities are similar but differ from environmental waste scavengers. These service operators constitute a minute part of the Private Sector Practitioners on waste management in urban areas (Agbebaku, 2022). They are the unaccredited service providers and unregistered waste managers, but are seen in the business of waste management to complement the efforts of big-time service operators. They operate as a result of a combination of factors such as; (a) the inadequacies of accredited and registered waste managers to effectively have a grip of their areas of coverage and (b)the need for self-sustainability and flexibility of their services delivery (ESWMB/Archival, 2018). They are mainly out to ease the public of the inconveniencies and poor waste disposal of refuse materials by humans. These service operators evacuate waste materials ranging from; types, compositions, and nature of waste materials from public places such as households, commercial,

industrial, institutions, and religious areas. These service operators operate daily in Benin City for monetary purposes (Ogu, 2000; Monday and Danieles, 2011; Agbebaku, 2018). As a result of the activities of the Environmental Free-Lancers the accredited private sector managers see them as threats to service delivery because of their sharp practices, yet the residents still need their services due to the shortcoming of government and private sector practitioners. Notwithstanding the importance of free-lancers, the operators from the private sector are considered more safe mainly due to their prompt service delivery, effectiveness, efficiencies, perseverance, and attitude (Agbebaku, 2018).

Waste Recycling in Benin City

One of the key functions of the Edo State Waste Management Board is to create a sustainable waste management system through responsible resource utilisation, waste reduction, reuse, and recycling initiatives. The principal actors involved in material recycling are the informal waste pickers and the private sectors. Plastics and rubber are the main recoverable material in Benin City (Plates 28 & 28). Others recoverable MSW are metals, bottle/glass, used textile materials etc. The frequency and rates of this material recovery, especially plastics, are due to the availability of market for these materials. Currently there is no market for organic waste; hence, the organic waste component of MSW is not a priority for pickers. At the government-approved Jubilant Citizen Resources dumpsite, recovered plastic materials are compressed at the dumpsite before transporting them out of the state for secondary, tertiary and quaternary recycling. Where this compressing facility is not available, waste pickers transport them to other locations where there is a compressing facility (Plate 30 & 31). Informal waste picking in Benin City is a lucrative business and women, men and young people are involved in the informal waste scavenging. These waste pickers operates both at dumpsites, on the streets (house-to-house collection services) and at illegal dumpsites (Plates 32 & 33).

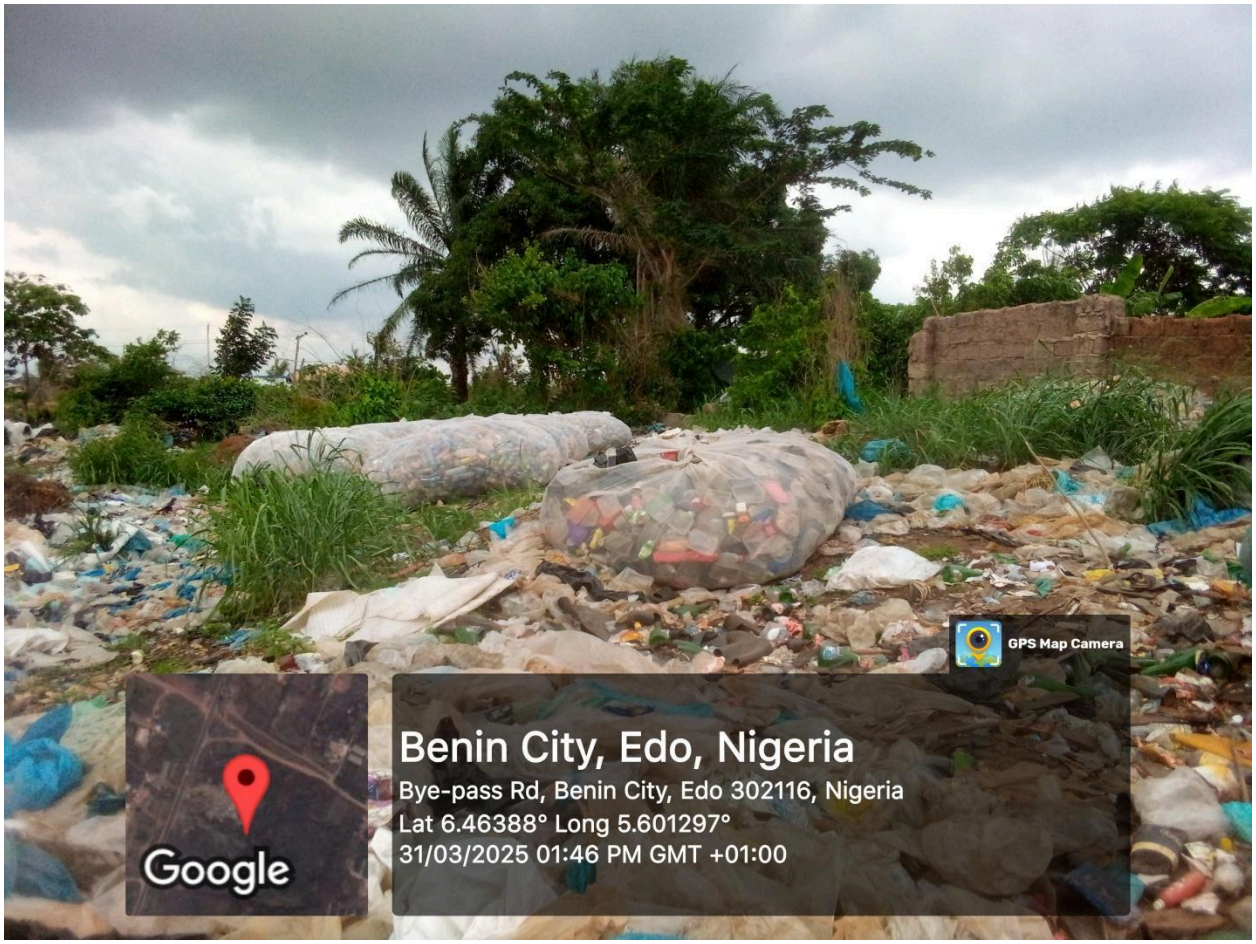


Plate 28: Recovered plastics material at Otofure dumpsite, awaiting removal to compressing facility

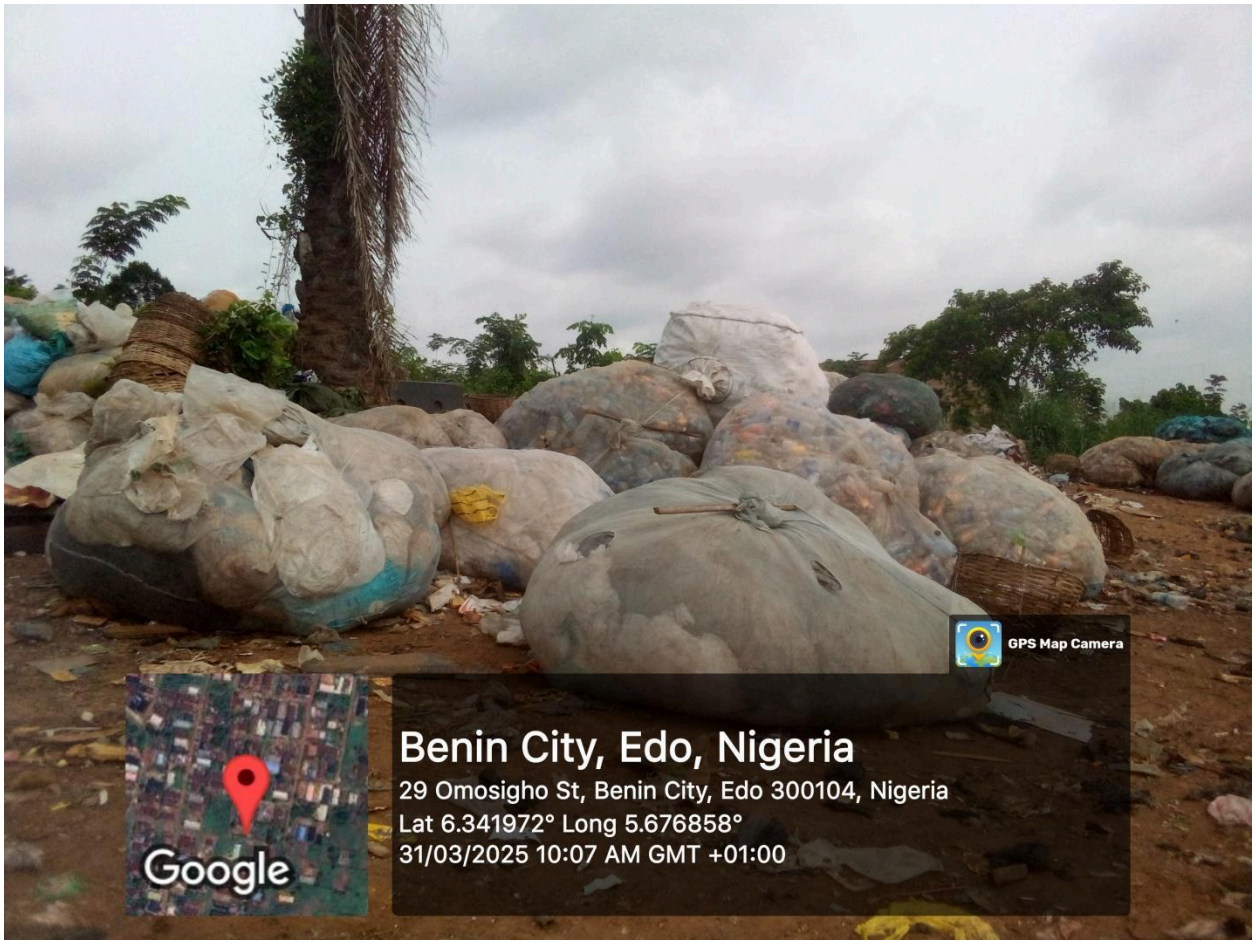


Plate 29: Recovered Plastics Material at Jubilant Dumpsite, Benin City (privately operated/licenced dumpsite)

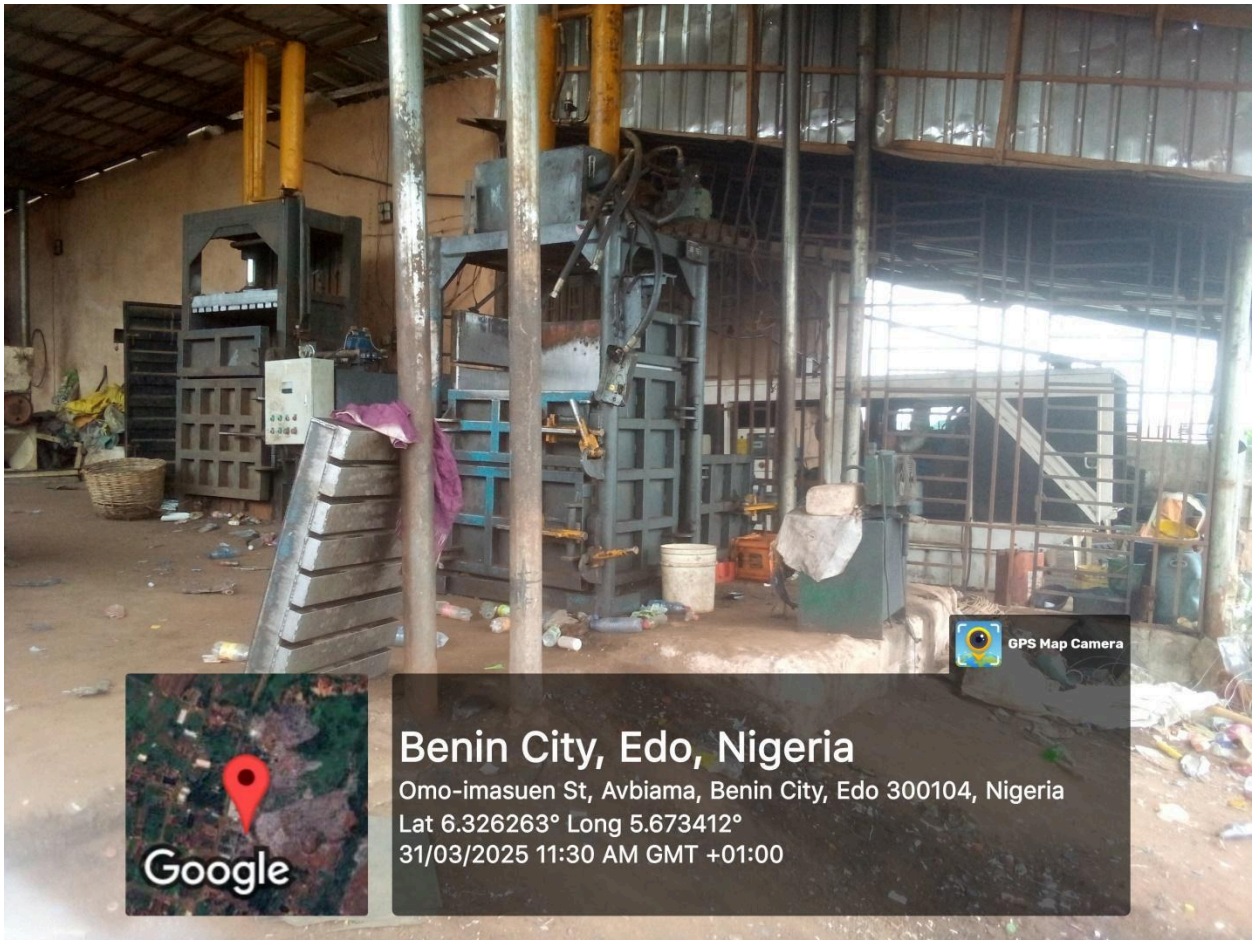


Plate 30: Plastics material compressing machine at jubilant dumpsite, Benin City (privately operated/licenced dumpsite)

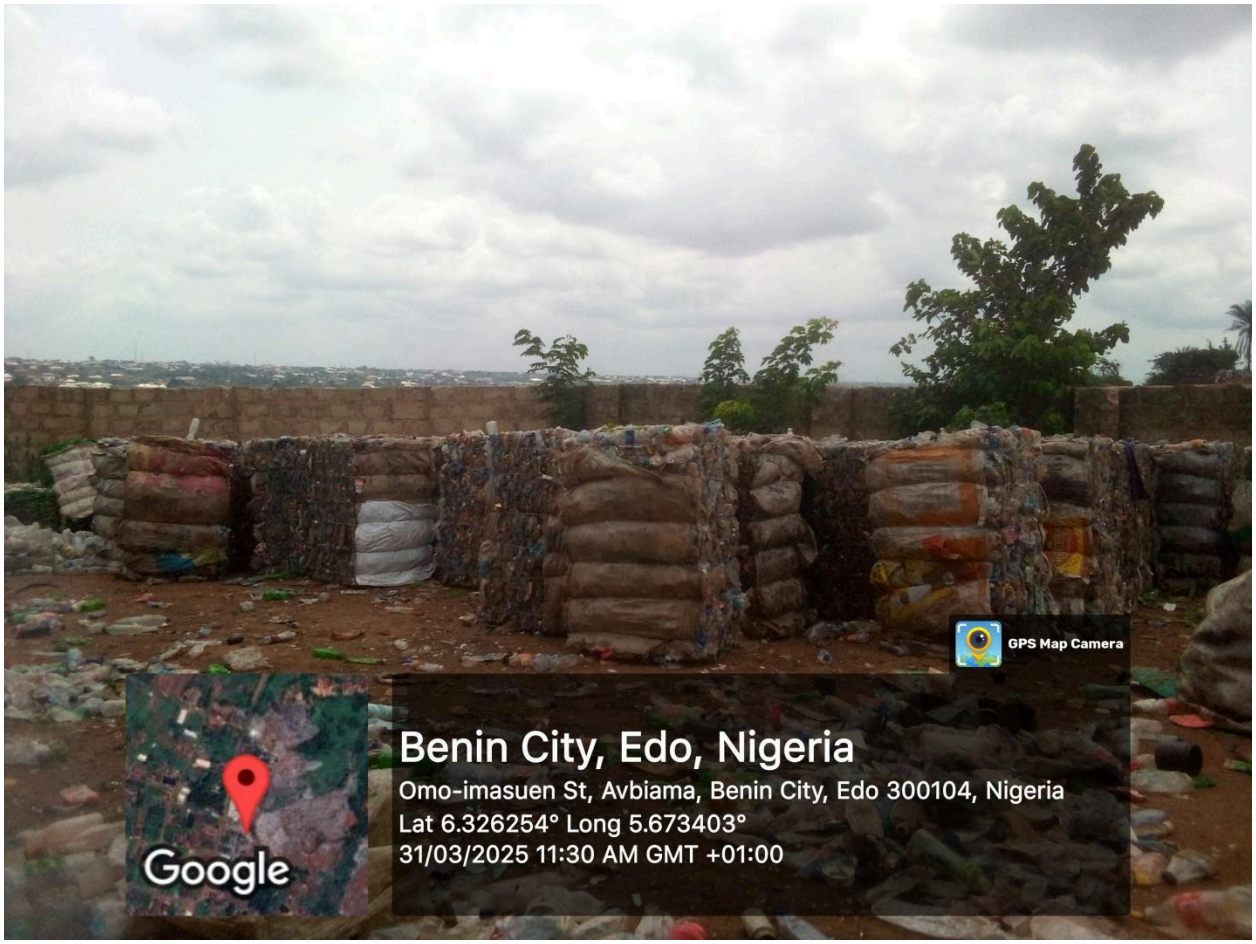


Plate 31: Compressed Plastics material at jubilant dumpsite, awaiting transportation to recycling company outside Edo State

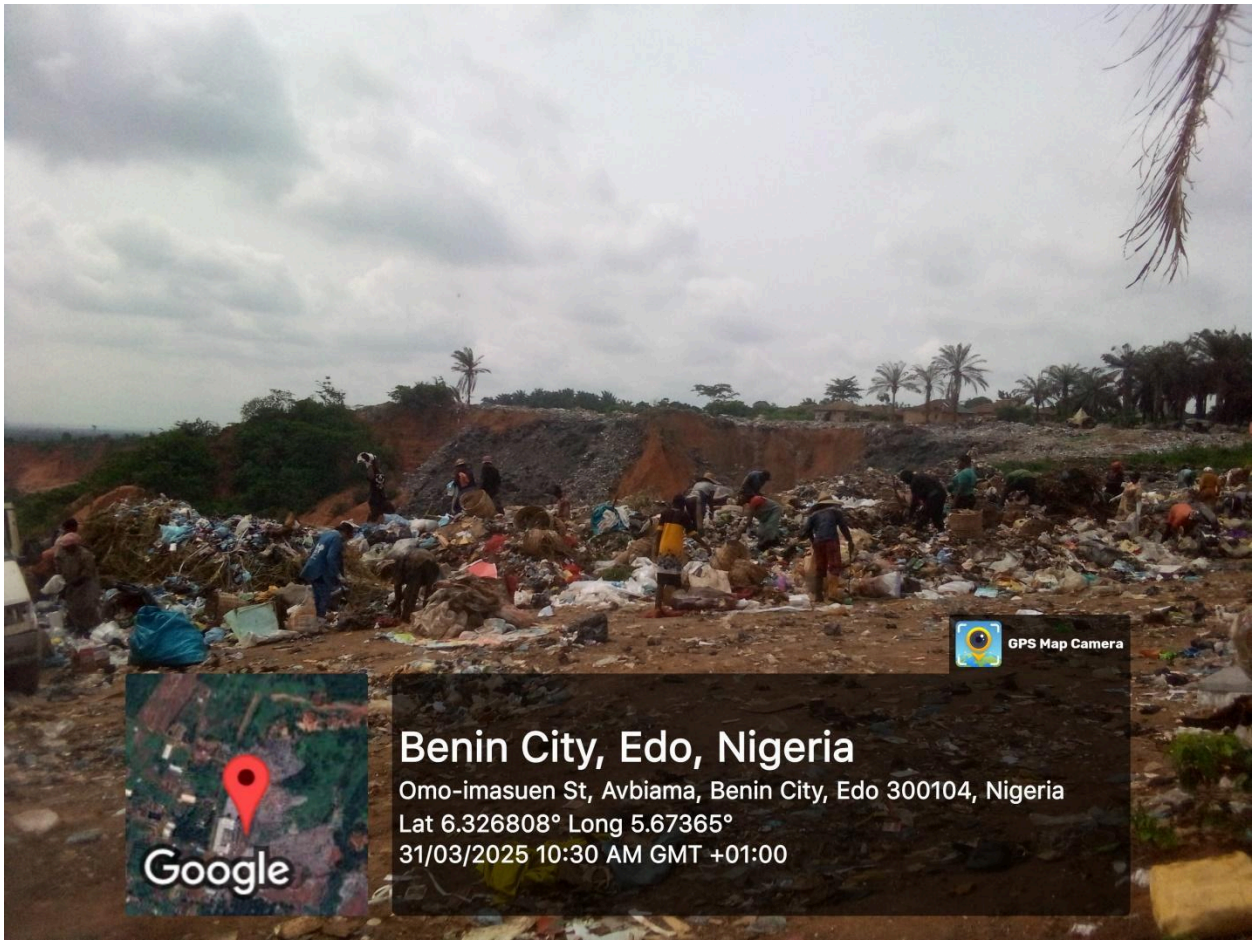


Plate 32: Recovering of materials at jubilant dumpsite, Benin City, Edo State. Women and children are key stakeholders

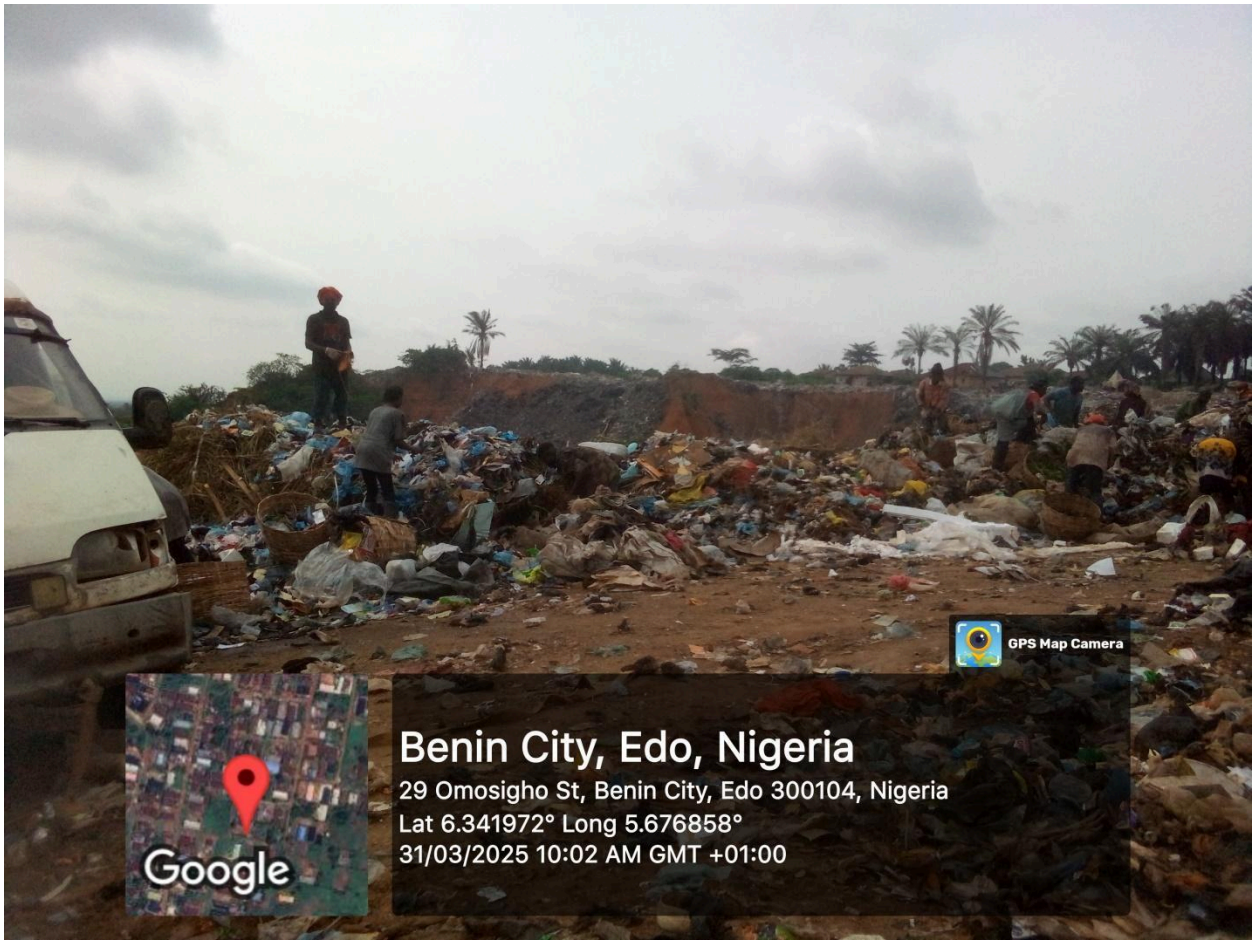


Plate 33: Recovering of materials at jubilant dumpsite, Benin City, Edo State

Challenges of Waste Management in Benin City

The contracting method of private sector participation in Edo State has not been wholly successful; the scheme may be regarded as a major attempt to provide a sustainable solution to poor waste management in the State, as well the introduction of some elements of community participation, decentralisation and a community-based service collection system. The weakness of waste management in Benin City can be seen from the wide-spread of illegal dumps and unevaluated waste littering streets and major roads in the city. Some residence have also opted out of the private sector collection arrangement citing irregularities in waste collection time and non-collection of waste from residence for months, a situation that usually result in overflowing of wastes which constitute environment nuisance.

Benin Moat and Gully Sites as Receptors of MSW

In addition to roadside and open space dumping of wastes, one common waste disposal practice in Benin City is the use of the Benin Moat and gully eroded site as receptors for MSW. According to Benin Kingdom (2023), the Benin moat, also known traditionally as Iya, is the largest man-made earthwork in the world. It predates the use of modern earth-moving equipment or technology in these parts. The moat encircles the old perimeter precincts of the City and was constructed as a defensive barrier in times of war. The Guinness Book of World Records describes the walls of Benin City as the world's second largest man-made structure after China's Great Wall, in terms of length, and the series of earthen ramparts as the most extensive earthwork in the world. Oba Oguola {about 1280-1295} dug the first and second moats to fortify the City from invaders, including the Imperial European invaders, who at the time were hunting for African slaves labourers. To stop the slave hunters from entering the kingdom, Oba Oguola further decreed that important towns and Villages should build similar moats as defence systems around their communities. This gave rise to twenty of such moats around Benin City and its environs. An extension of the moat was constructed in the 15th century during the reign of Oba Ewuare. During the second half of the 15th century, Oba Ewuare the Great (ruled 1440-1473 AD) ordered a moat to be dug in the heart of the city. The earthworks served as a bastion and also afforded control of access to the capital which had nine gates that were shut at night. The Benin moat is over 3200 kilometers long and in total, the Benin wall system encompasses over 10,000 kilometers (6213.7 miles) of earth boundaries. With the Moat still open most residents of Benin City now disposal of their waste into this moat (Plates 34-36). Disposal of waste into the Benin Moat and guly eroded land has implications for surface and groundwater pollution.

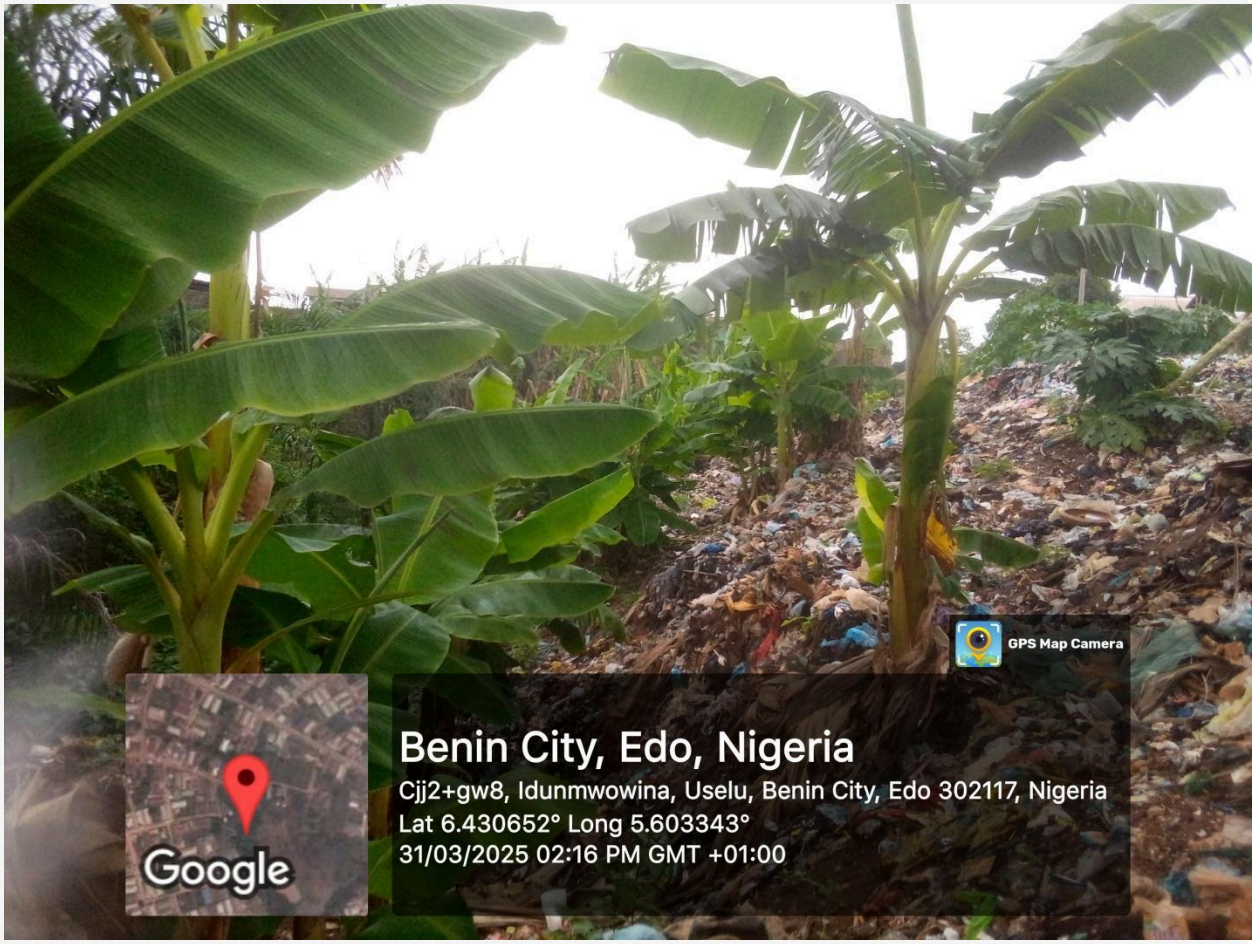


Plate 34: Waste disposal into an extension of Benin Moat, At Idunmwowina, Benin City

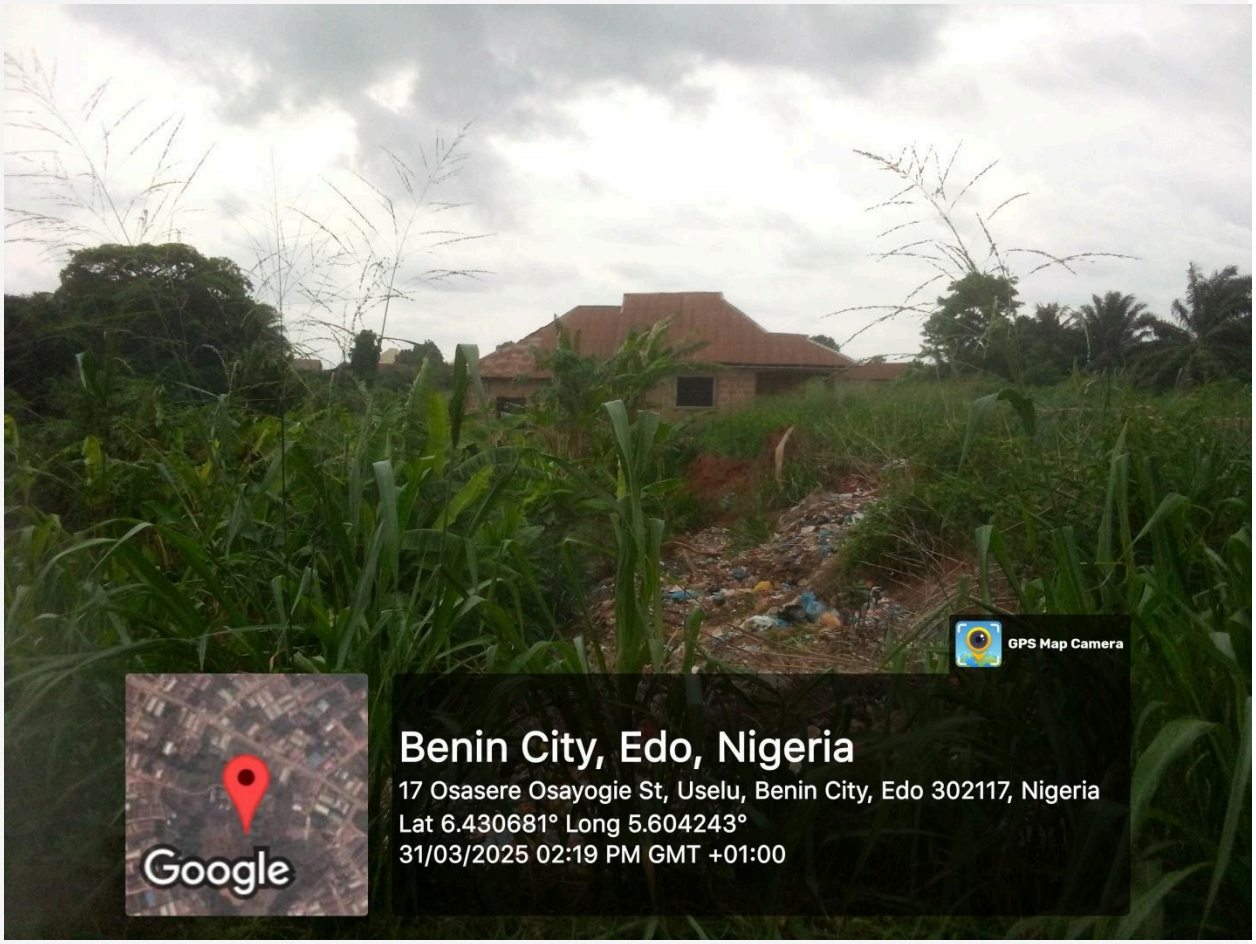


Plate 35: Waste disposal into an extension of Benin Moat, At Osasere Osayogie, Benin City

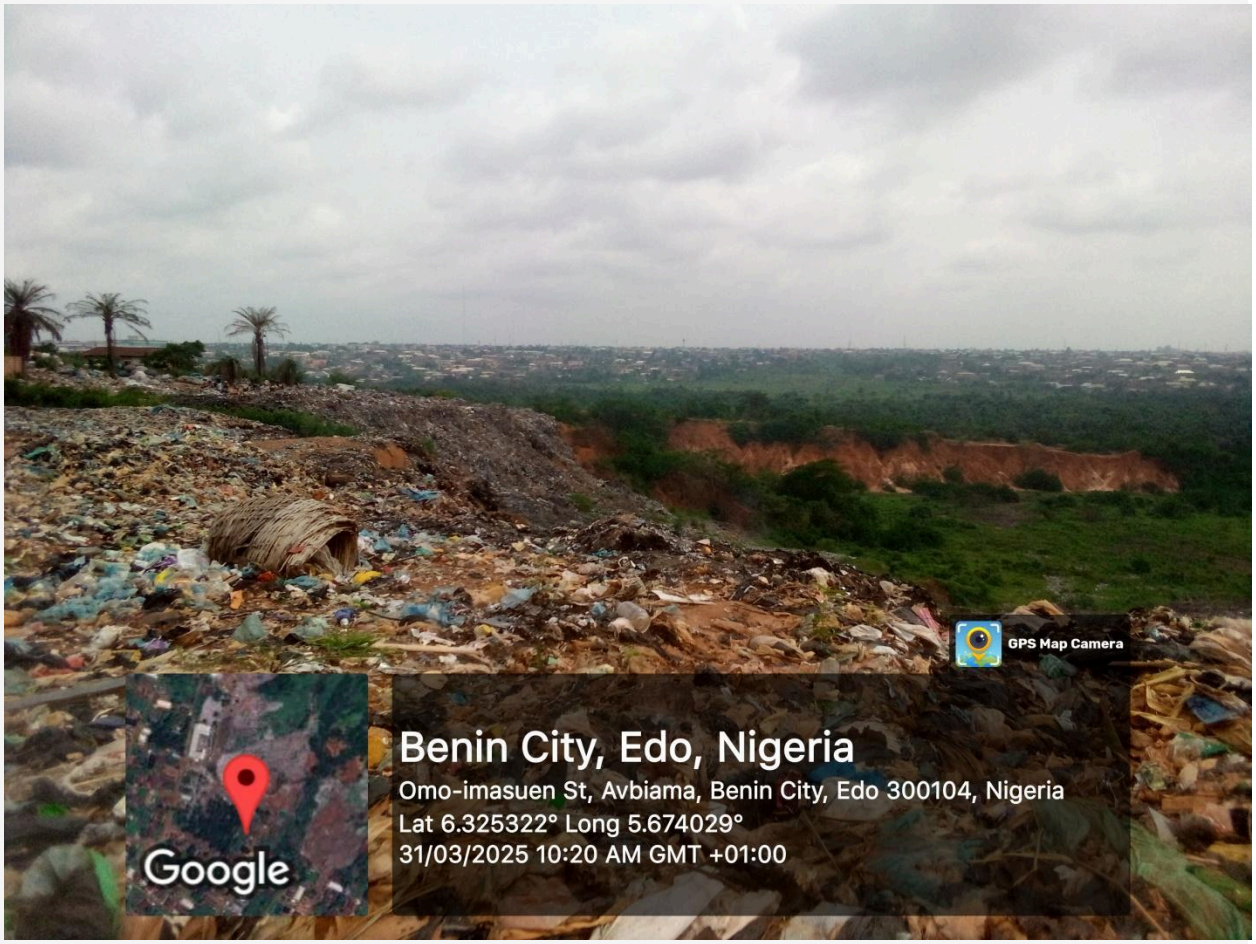


Plate 36: Waste disposal into degraded land, (privately operated/approved dumpsite) in Benin City

10.2. Situation in Epe Town, Lagos State

Lagos State, known as Nigeria's economic centre, is under pressure to manage its waste due to increasing population and enhanced urbanization. The Lagos State Waste Management Authority (LAWMA) is leading the way in lessening these pressures by handling the entire waste management continuum—from collection through disposal. Lagos is a megacity with a GDP exceeding $131 billion (Okeowo and Fatoba, 2022). The City has 20 Local Government Areas (Lagos Bureau of Statistics, 2010) and a population of approximately 21 million (World Population Review, 2024). Lagos produces approximately 13,000 – 15,000 metric tons of solid waste, equivalent to approximately 490 trailers per day (Punch, 2024, https://punchng.com/lagos-needs-sanitation-to-tackle-its-dirtiness/). Informal settlements and poor waste disposal practices exacerbate these issues. Between 1960 and 1970, waste management in Lagos State involved only dumping and burning (Yakubu, 2017). The oil boom,

industrialization, and urbanization of the early 1970 s led to a surge in waste generation, which challenged the Lagos Local Government Council. By 1977, Lagos was labelled the "dirtiest" capital city during the Festival of Arts and Culture (FESTAC '77; Mondo4Africa, 2024), resulting in the Powell Duffen Pollution Control Consultant's establishment of the Lagos State Refuse Disposal Board in 1977 (Lagos State Government, 2024), an authority that became the Lagos State Garbage Disposal Board in 1981 and LAWMA in 1991. The LAWMA Act of 2007 and the Environmental Management and Protection Law of Lagos grant LAWMA extensive authority, including waste recovery for economic growth (Environmental Management and Protection Law of Lagos State, 2017; LAWMA 2021). The waste management authority noted: "The 2017 environmental management and protection Law of Lagos stipulates that LAWMA is saddled with the responsibility of managing the solid waste in Lagos and that law entails the structure of LAWMA." Since 1991, LAWMA has made significant efforts to change the narrative of FESTAC'77, and recently, the authority has emphasized its commitment to improving recycling, converting organic waste into compost and biogas (Vanguard, 2024), and increase private sector participation.

Historical Evolution of Waste Management in Lagos

The development of organized waste management in Lagos started in 1977 with the creation of the Lagos State Refuse Disposal Board (LSRDB). This initiative was a response to the growing waste issues that accompanied the state's urbanization and expansion. Over the years, the agency has undergone several reforms:

- 1981: The LSRDB's responsibilities were broadened to include the collection of industrial and commercial waste, clearing of drains, and the removal of abandoned vehicles, prompting a name change to the Lagos State Waste Disposal Board (LSWDB).
- 1991: In light of the need for a more integrated approach, the agency was renamed the Lagos State Waste Management Authority (LAWMA) to better represent its expanded functions in managing both municipal and industrial waste. (Source: https://lawma.gov.ng/)

Waste Collection Mechanisms in Lagos State

Lagos State operates a structured waste collection system to address the high volume of solid waste generated daily. The Lagos State Waste Management Authority (LAWMA) leads this effort in collaboration with private sector participants (PSPs) and other waste management

stakeholders. The collection process is categorized into residential, commercial and industrial, and public space waste management.

Residential Waste Collection

Residential waste collection in Lagos is primarily managed through a public-private partnership between LAWMA and licensed Private Sector Participants (PSPs). These PSPs are responsible for collecting and transporting domestic waste from households to designated transfer stations or landfill sites (LAWMA, 2023). To ensure efficiency, households are encouraged to place their waste bins outside, the night before scheduled collection days. Collection frequency varies depending on the area, with high-density neighbourhoods receiving more frequent services than lower-density ones. Residents are required to subscribe to waste collection services provided by the PSPs, with fees determined based on the location and the volume of waste generated. The payment for these services is often billed monthly, and non-compliance can result in fines or disruptions in service (LAWMA, 2023). The government has also introduced initiatives to improve waste segregation at the household level, promoting recycling and reducing the amount of waste sent to landfills (Ogunbiyi, 2022). Despite these efforts, challenges such as inadequate PSP coverage, irregular collections, and the persistence of illegal dumpsites still plague the system. LAWMA has introduced monitoring mechanisms, including digital tracking of waste collection vehicles, to enhance accountability and service efficiency (LAWMA, 2023).

Commercial and Industrial Waste Collection

Unlike residential waste, the collection and disposal of commercial and industrial waste in Lagos are managed directly by LAWMA. This category includes waste from office buildings, markets, manufacturing plants, and hospitality establishments. Due to the diverse nature of waste generated by these sectors, specialized collection and treatment methods are employed (Lawnigeria, 2023). Industries producing hazardous and biomedical waste, such as hospitals and pharmaceutical companies, adhere to stringent disposal guidelines. LAWMA provides tailored waste collection services for such waste streams, ensuring compliance with environmental and public health regulations. Waste generators in these sectors are required to obtain proper waste disposal licenses, and failure to comply can result in penalties, including business closures (Environmental Management and Protection Law of Lagos State, 2017). To improve efficiency, some industrial estates and business districts have adopted waste compaction and recycling

technologies, reducing the volume of waste requiring transportation to landfills (Oke and Olubanjo, 2021). However, enforcement of regulations remains inconsistent, leading to occasional instances of illegal dumping by non-compliant businesses.

Waste Collection in Public Spaces and Highways

Maintaining cleanliness in public spaces such as streets, highways, markets, and parks is another crucial aspect of Lagos' waste management strategy. LAWMA, in partnership with Highway Managers Limited and Market unions, is responsible for cleaning and waste collection in these areas (LAWMA, 2023). Street sweepers are deployed daily to major roads, bridges, and highways to remove litter and debris. Despite these efforts, indiscriminate dumping of waste in drainage systems and unauthorized locations remains a challenge (Plates 37-39). The Lagos State Government continues to implement awareness campaigns and enforcement measures to deter such practices. Additionally, mobile waste collection trucks operate in areas with heavy foot traffic to provide on-the-spot waste management solutions (Ogunbiyi, 2022). Overall, while Lagos' waste collection system has evolved significantly, persistent challenges such as inadequate infrastructure, enforcement gaps, and public non-compliance continue to hinder optimal waste management. The government's on-going efforts to integrate modern waste processing technologies and private sector investment remain essential for sustaining improvements in waste collection and overall environmental sanitation.

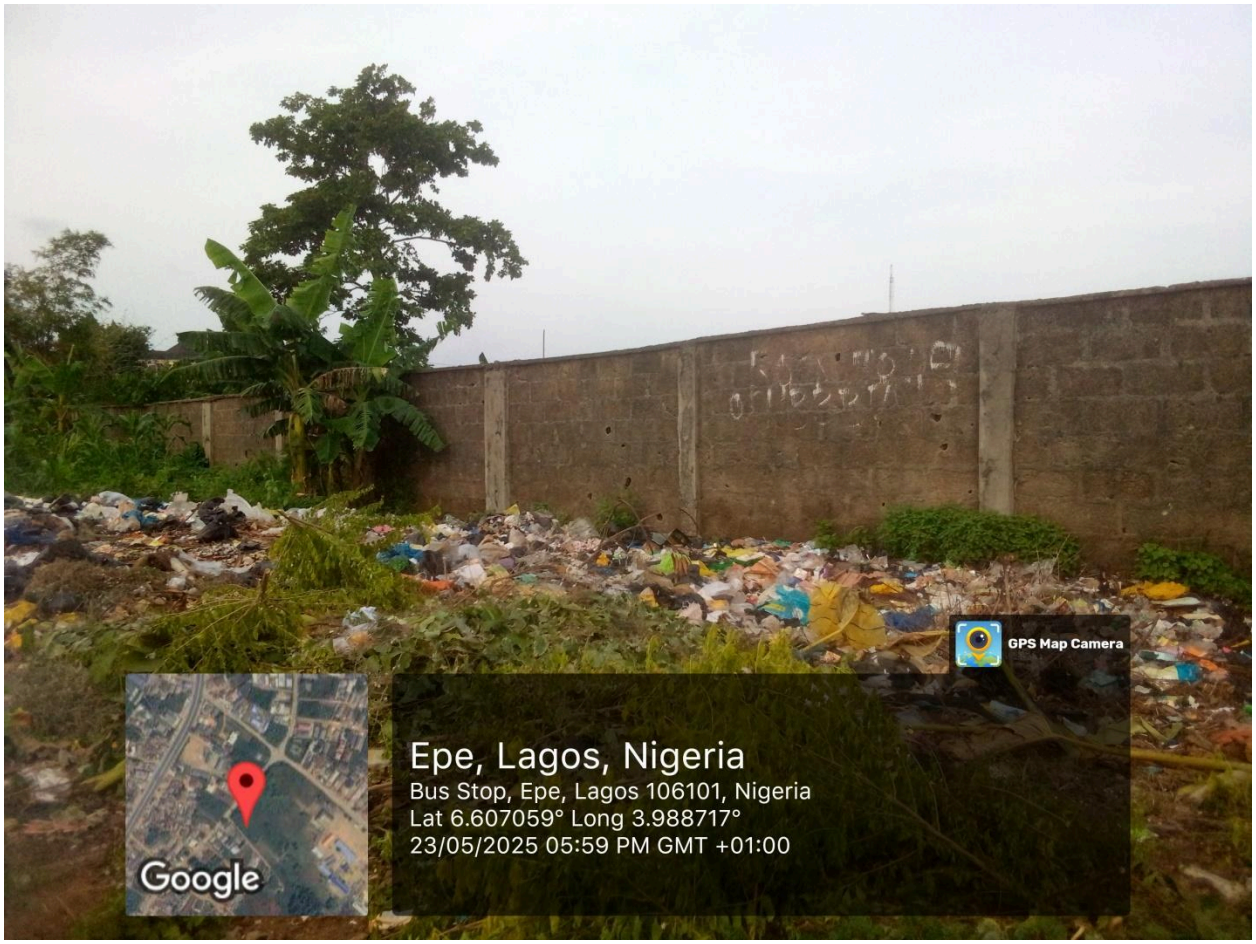


Plate 37: Unregulated dumping of household refuse in open space in Epe town, Lagos State

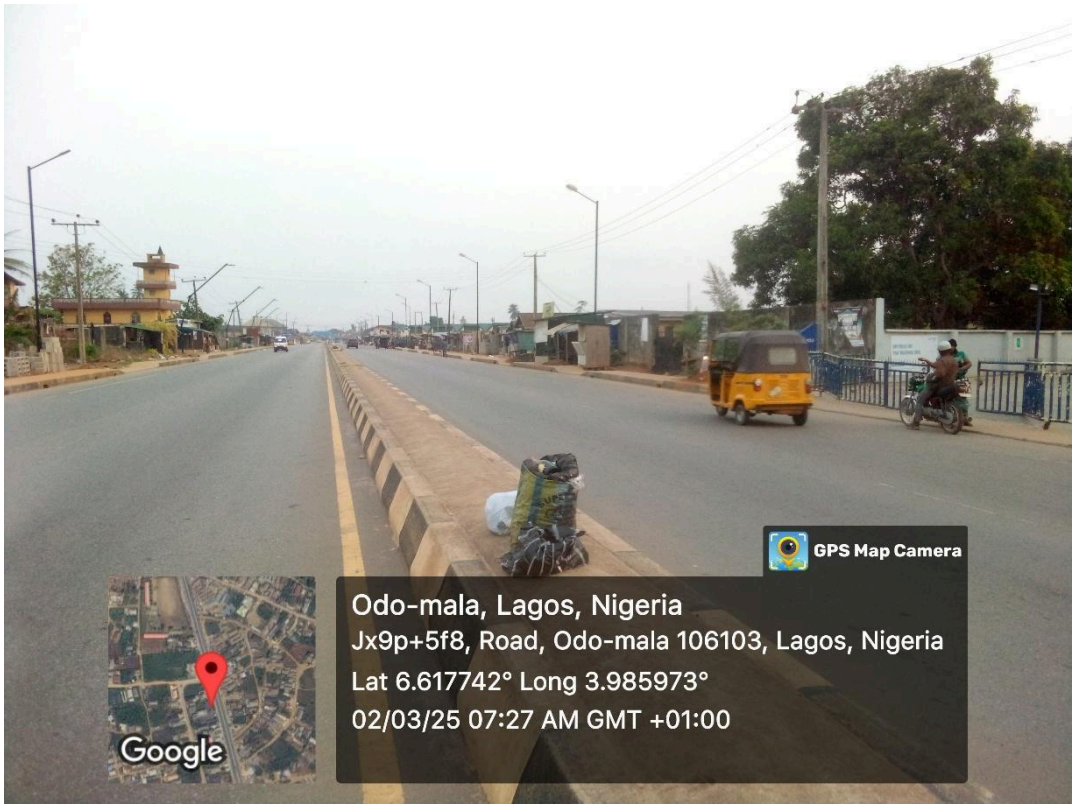


Plate 38: Illegal dumping of waste on highway in Odo-Male, Lagos

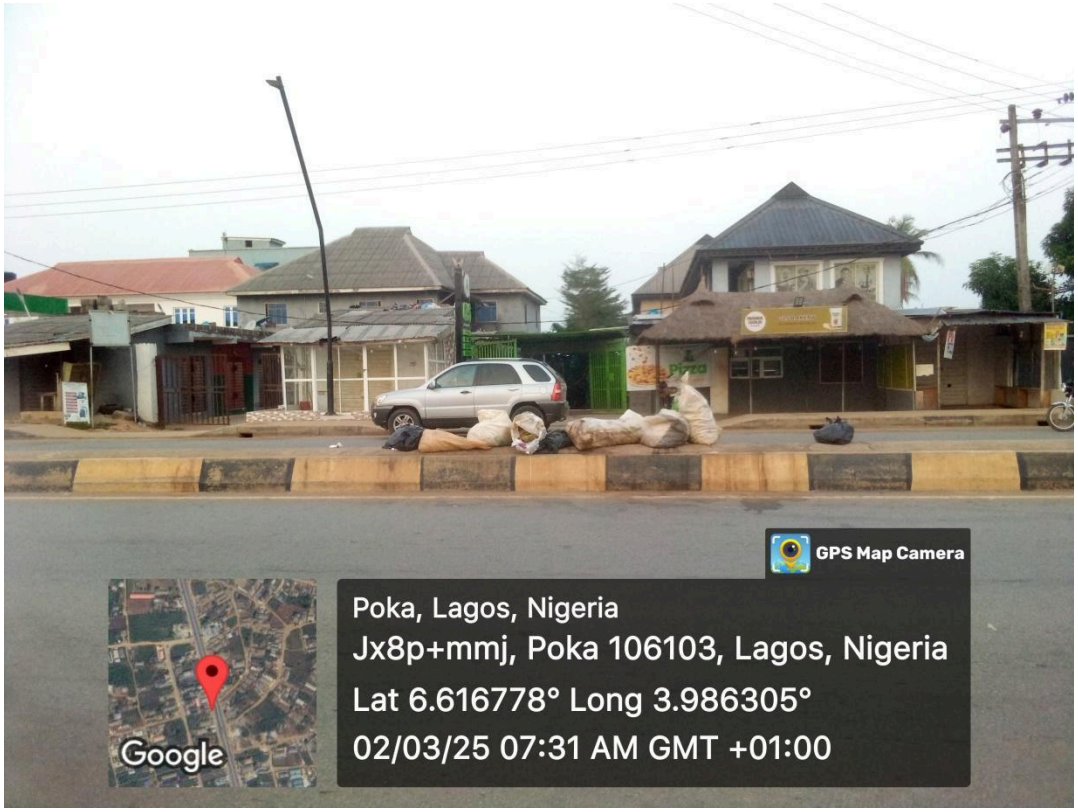


Plate 39: Unregulated dumping of along Marina Rd, Epe Lagos

Provision of Waste Bins

To enhance proper waste storage and minimize indiscriminate dumping, the Lagos State Waste Management Authority (LAWMA) has implemented a structured waste bin distribution system for both residential and commercial entities. These standardized bins are designed to be durable, weather-resistant, and suitable for different waste types to ensure efficient collection and disposal (LAWMA, 2023).

Residential Waste Bins

LAWMA provides residents with standardized waste bins, which are primarily intended for the storage of household waste before scheduled collection. The bins are made from high-density polyethylene materials, making them resistant to harsh weather conditions and ensuring longevity (Ogunbiyi, 2022). The agency encourages households to properly use these bins and place them outside their premises on designated collection days. Failure to utilize the provided bins appropriately can attract fines, particularly in areas where waste dumping remains a challenge (Environmental Management and Protection Law of Lagos State, 2017).

To further improve waste segregation at the household level, LAWMA has introduced a color-coded bin system. Under this initiative, separate bins are assigned for different types of waste:

- **Green bins** – for organic and biodegradable waste, such as food scraps and garden waste.
- **Blue bins** – for recyclables, including plastics, glass, and paper.
- **Black bins** – for non-recyclable waste, designated for landfills (LAWMA, 2023).

Despite these efforts, some areas still experience inadequate bin distribution, leading to improper waste disposal. LAWMA has collaborated with local government authorities to expand bin coverage and ensure wider accessibility (Vanguard, 2023).

Commercial and Industrial Waste Bins

Businesses, offices, markets, and industries are required to use LAWMA-approved waste bins for proper waste management. Unlike residential waste bins, commercial bins are often larger and more robust, with some businesses opting for wheeled dumpsters to accommodate higher volumes of waste. In compliance with Lagos State's environmental regulations, commercial

establishments must ensure their waste is properly stored in designated bins before being collected by either LAWMA or private waste management operators (Lawnigeria, 2023).

Certain industries that generate specialized waste, such as hospitals and manufacturing plants, are mandated to use specific waste containment systems. For instance, medical facilities must use color-coded bins for hazardous waste, including red bins for infectious materials and yellow bins for sharps and pharmaceutical waste (Oke and Olubanjo, 2021). LAWMA enforces these regulations through periodic inspections to ensure compliance with waste storage and disposal guidelines.

Public Waste Bins and Recycling Initiatives

To tackle littering in public spaces, LAWMA has installed waste bins in strategic locations across Lagos, including markets, highways, parks, and bus terminals (Plate 40a&b). These bins serve as temporary waste collection points before final disposal by waste collection teams. However, reports indicate that some areas suffer from a shortage of public bins, leading to frequent littering and unauthorized dumpsites (Ogunbiyi, 2022).



Plate 40a&b: Public Waste Bins in Epe Town, Lagos State

To promote recycling and reduce landfill waste, LAWMA has partnered with private recycling firms and non-governmental organizations to distribute additional color-coded bins in communities, schools, and businesses. The goal of this initiative is to encourage source separation of waste and increase recycling rates. Awareness campaigns have been launched to educate residents on the importance of proper waste sorting and the benefits of recycling, including economic opportunities in the recycling sector (Vanguard, 2023).

Waste Disposal Practices in Lagos State

Once waste is collected from households, businesses, and public spaces, it is transported to designated disposal sites for final treatment. The Lagos State Waste Management Authority (LAWMA) oversees the transportation and disposal of waste, ensuring compliance with environmental regulations and global best practices in waste management.

i. Transportation of Waste

Waste collection trucks operated by both LAWMA and Private Sector Participants (PSPs) transport waste from collection points to transfer loading stations (TLS) before being moved to final disposal sites. This two-stage process allows for more efficient waste management, as transfers stations help reduce travel distances for collection trucks while improving the logistics of final disposal (LAWMA, 2023). The waste transportation system is structured as follows:

- **Primary Collection:** PSPs collect waste from households and businesses using medium-sized waste trucks or compactor vehicles. Waste is temporarily stored at transfer stations before bulk transportation.
- **Secondary Collection:** Larger waste haulage trucks transport waste from transfer stations to landfill sites or recycling centres. This stage optimizes fuel usage and reduces road congestion caused by smaller collection trucks.
- **Specialized Waste Transport:** Hazardous, medical, and industrial waste is transported separately in specialized vehicles to ensure compliance with safety standards. These vehicles are equipped with leak-proof containment and tracking systems to prevent contamination (Lawnigeria, 2023).

LAWMA has introduced digital monitoring systems that track waste transportation vehicles in real-time, helping to prevent illegal dumping and ensuring timely disposal (Vanguard, 2023).

ii. Designated Disposal Sites in Lagos

LAWMA manages several landfill sites in Lagos, where collected waste is disposed of in an environmentally safe manner. These landfills are designed to minimize public health risks and environmental degradation while accommodating the massive volume of waste generated daily. The major landfill sites in Lagos include:

- **Olusosun Landfill**

The Olusosun Landfill, located in Ojota, spans approximately 100 acres and has been in operation since 1992. As the largest landfill site in Lagos, it receives over 40% of the state's solid waste daily, accommodating thousands of tons of municipal, commercial, and industrial waste (LAWMA, 2023). Despite its significance in waste management, Olusosun has been plagued by various operational and environmental challenges, including:

- Frequent Fire Outbreaks: Uncontrolled decomposition of organic waste generates methane gas, a highly flammable greenhouse gas. Several fire incidents have been recorded, particularly in 2018, when a major inferno disrupted waste disposal activities and affected nearby residents (Ogunbiyi, 2022).
- Methane Emissions: The site lacks an adequate landfill gas capture system, leading to the uncontrolled release of methane, which contributes to air pollution and climate change (LAWMA, 2023).
- Unregulated Waste Picking: The landfill supports an informal waste recycling sector, with over 3,000 scavengers sorting through waste daily. However, the lack of structured recycling mechanisms poses health hazards to waste pickers and residents (Ogunbiyi, 2022).

Recognizing these challenges, the Lagos State Government has initiated plans to transform Olusosun into an integrated waste management facility. According to LAWMA, (2023), "the proposed waste-to-energy project will utilize landfill gas to generate electricity, reducing reliance on fossil fuels and minimizing uncontrolled methane emissions.

❖ **Epe Landfill**

The Epe Landfill, covering over 80 hectares, is one of the newly engineered landfill sites in Lagos. Unlike traditional open dumpsites, Epe was designed with modern waste treatment features to address environmental concerns.

Key Features of Epe Landfill

- Leachate Management System: The landfill incorporates an advanced leachate collection system that prevents the contamination of underground water sources, protecting nearby rivers and groundwater supplies (Oke & Olubanjo, 2021).
- Sustainable Waste Treatment: Epe Landfill integrates waste separation and composting technologies, which enable organic waste to be processed into fertilizers instead of being, landfilled (Oke & Olubanjo, 2021).
- Waste-to-Energy Potential: The site has been identified by the Lagos State government as a potential waste-to-energy facility, similar to planned upgrades at Olusosun, aimed at converting waste into renewable electricity (LAWMA, 2023).

Epe Landfill was developed to relieve pressure on older dumpsites, particularly Olusosun, and is part of Lagos State's broader waste decentralization strategy.

❖ **Solous Landfills (I, II, and III)**

Located along the Lagos-Badagry Expressway, the Solous landfill cluster (comprising Solous I, II, and III) serves as a major disposal site for waste generated in the Alimosho and Ojo areas. These landfill sites receive a mix of municipal solid waste, industrial waste, and organic waste (LAWMA, 2023).

Sustainable Waste Management at Solous Landfills

- Biogas Production Potential: Solous landfills have been earmarked for biogas production, where organic waste will be converted into methane for electricity generation.
- Rehabilitation and Closure Plans: As part of Lagos' Sustainable Waste Management Strategy, portions of Solous I and II are set to be closed and rehabilitated, while Solous III will be upgraded into a modern waste treatment facility (LAWMA, 2023).

- **Abule-Egba and Igando Dumpsites**

The Abule-Egba and Igando dumpsites primarily receive construction and demolition waste, playing a crucial role in land reclamation projects across Lagos. Instead of disposing of waste in landfills, certain materials, such as concrete, asphalt, and sand, are repurposed for infrastructure development.

Key Functions of Abule-Egba and Igando dumpsites

- Land Reclamation: Waste materials from Abule-Egba and Igando are used to stabilize low-lying areas, reducing the risk of flooding and expanding available land for housing and road construction (Vanguard, 2023).
- Recycling of Construction Waste: Some waste is processed into gravel and aggregates, reducing the demand for natural resources like quarry stones and sand.
- Reducing Pressure on Main Landfills: By diverting construction debris from Olusosun and Epe, these dumpsites help extend landfill lifespan and lower environmental impact (Vanguard, 2023).

Environmental and Health Safety Measures in Landfill Operations being put in place by the Lagos State Government

According to LAWMA, for the state to align its current waste management processes with global waste management best practices, LAWMA has implemented the following measures at landfill sites:

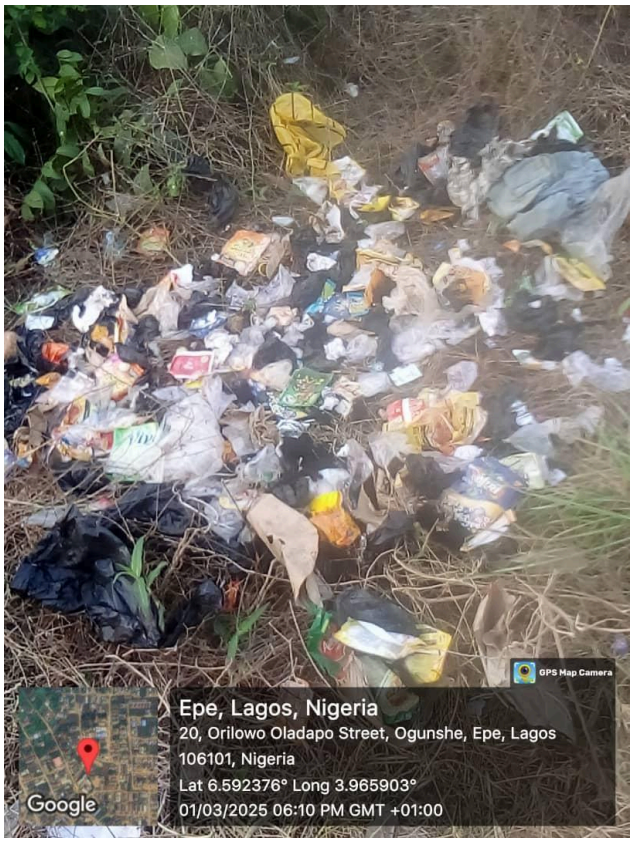
- **Methane Gas Recovery:** Some landfill sites have started methane gas capture initiatives to prevent greenhouse gas emissions and reduce fire hazards (LAWMA, 2023).
- **Leachate Treatment Systems:** Engineered landfills like the Epe site incorporate drainage systems to collect and treat toxic leachate, preventing contamination of underground water sources (Oke & Olubanjo, 2021).
- **Landfill Closure and Rehabilitation:** Old dumpsites, such as Olusosun, are being considered for closure and transformation into recreational parks or renewable energy hubs (Ogunbiyi, 2022).

- **Waste-to-Energy Initiatives**: Lagos is investing in waste-to-energy conversion technology, which involves turning biodegradable waste into biogas for electricity generation (Lawnigeria, 2023).

Challenges of MSW Management in Lagos State

Despite improvements in landfill management, Lagos still faces several challenges, including:

- **Over-reliance on landfills:** The city still depends heavily on landfilling, while advanced waste treatment methods such as incineration and composting remain underutilized.
- **Illegal Dumping:** Some PSPs and waste generators illegally dump waste in unauthorized locations, leading to environmental hazards.
- **Limited Recycling Infrastructure:** While LAWMA is promoting waste segregation and recycling, there is still a lack of large-scale recycling plants to handle the volume of recyclable materials generated in Lagos (Vanguard, 2023).
- **Inefficiencies in Waste Collection and Recycling in Lagos State**: Lagos with a population exceeding 21 million people (World Population Review, 2024), faces significant challenges in waste collection and recycling. The city produces an estimated 13,000 to 15,000 metric tonnes of waste daily, yet only 40% of this waste is collected efficiently, leaving large volumes unaccounted for, (LAWMA, 2024) (Plate 41a&b). This result in widespread environmental degradation, blocked drainage systems, and increased public health risks, particularly in low-income and informal settlements where waste collection services are inconsistent.



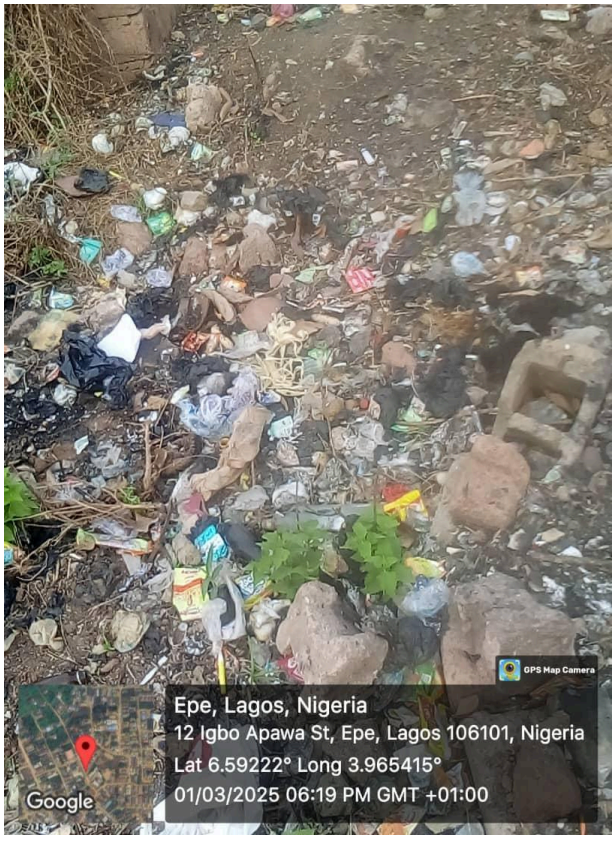


Plate 41a&b: Improper MSW dumping in open space in Epe Town

- **Limited Collection Coverage and Infrastructure Constraints:** The rapid urbanization of Lagos has outpaced its waste management infrastructure, with many areas experiencing irregular or non-existent waste collection services. Informal settlements and densely populated neighbourhoods often rely on improvised dumping methods, such as burning waste or disposing of it in canals, leading to air and water pollution (Ogwueleka, 2021). The Lagos Waste Management Authority (LAWMA) collaborates with Private Sector Participants (PSPs) to manage waste collection, but inefficiencies in route planning, funding constraints, and operational bottlenecks hinder comprehensive coverage (LAWMA, 2023). Many PSPs also struggle with fuel price fluctuations, inadequate truck maintenance, and delays in government subsidies, further impacting collection efficiency (Punch, 2024, https://punchng.com/lagos-needs-sanitation-to-tackle-its-dirtiness/).
- **Overflowing Dumpsites and Poor Waste Disposal Practices:** One of the most pressing issues in Lagos waste management system is the overflowing capacity of landfill sites, particularly the Olusosun dumpsite, and the largest landfill in West Africa. Olusosun receives up to 10,000 metric tonnes of waste daily, far exceeding its designed capacity, leading to hazardous living conditions for surrounding communities (Wikipedia, 2024). Originally located on the outskirts of Lagos, rapid urban expansion has brought residential areas closer to the dumpsite, increasing exposure to airborne toxins, groundwater contamination, and respiratory diseases among local residents (Akinbile & Ogunniyi, 2022). The open burning of waste, a common practice to reduce landfill volume releases methane, carbon monoxide, and dioxins, which contribute to climate change and pose severe health risks (UNEP, 2023).
- **Low Recycling Rates and Inefficient Waste Sorting:** Despite producing high volumes of waste, Lagos recycles only about 13% of its waste, well below global standards (Vanguard, 2024). The recycling sector remains underdeveloped due to limited investments, lack of waste segregation at the source, and low public awareness. While LAWMA has introduced color-coded recycling bins, uptake remains low due to inconsistent distribution, lack of enforcement, and inadequate incentives for households and businesses to separate recyclables (LAWMA, 2024). Additionally, the informal sector

dominates recycling efforts, with thousands of waste pickers' manually sorting waste from dumpsites, often under hazardous conditions and without protective equipment (Adebola, 2023) (Plate 42).

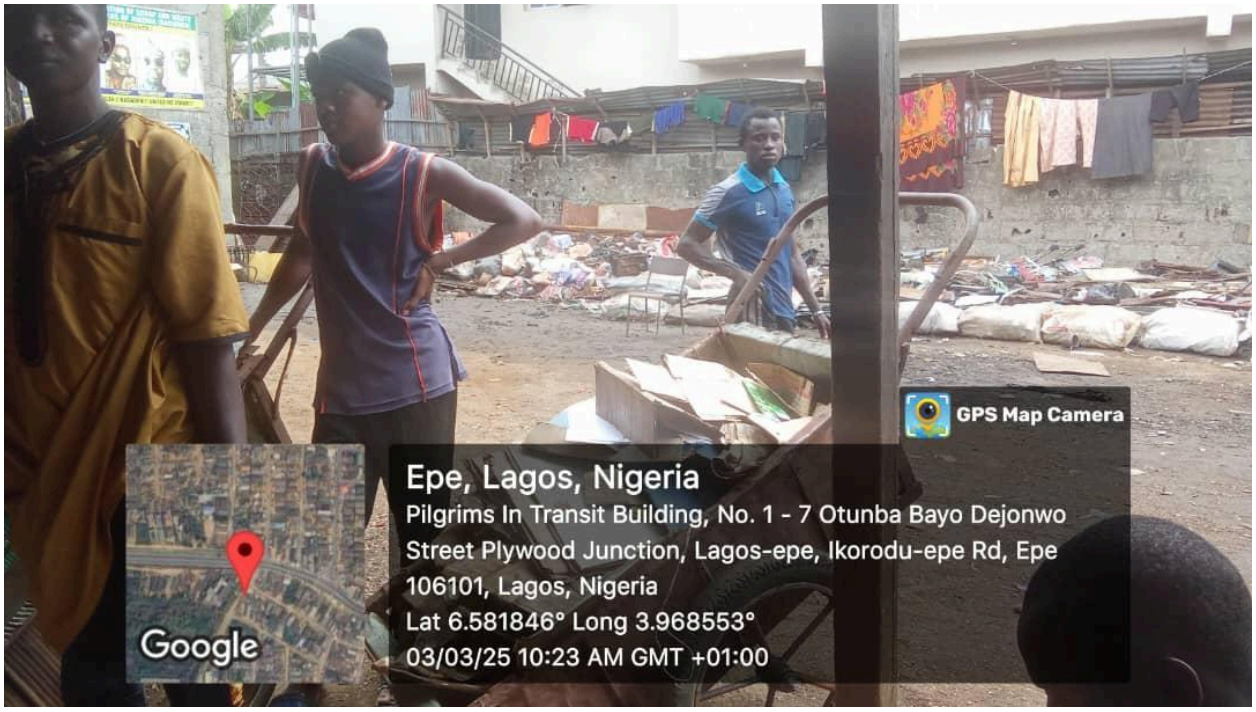


Plate 42: Waste pickers in Epe Town Lagos State

- **Electronic and Plastic Waste Proliferation in Lagos:** Lagos has emerged as one of the largest hubs for electronic waste (e-waste) in Africa, receiving an estimated 71,000 metric tonnes of e-waste annually (BAN, 2023). A significant portion of this waste arrives through illegal imports, often mislabelled as "second-hand electronics" to circumvent international regulations such as the Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal (Basel Convention, 2024). Additionally, the city's heavy consumption of single-use plastics has exacerbated pollution, leading to severe environmental and health challenges.
- **Unregulated E-Waste Processing and Its Hazards:** The informal sector dominates e-waste recycling in Lagos, with thousands of scavengers working under hazardous conditions to extract valuable metals such as copper, gold, and aluminium from discarded devices (Babayemi et al., 2022). One common method involves burning electrical cables to retrieve copper wiring, a process that releases toxic substances like dioxins, furans, and

heavy metals into the air (Wikipedia, 2024). Studies have linked exposure to these emissions with respiratory diseases, neurological disorders, and increased cancer risks among workers and surrounding communities (Igharo & Oloyede, 2023). Furthermore, lead and mercury contamination from improperly disposed batteries and circuit boards seeps into groundwater supplies, endangering public health (Obaje, 2023). Lagos lacks proper e-waste processing facilities, relying instead on informal dumpsites such as Olusosun, Alaba, and Ikeja Computer Village, where crude recycling methods prevail (Ogunseye, 2024). Despite the presence of some registered e-waste recyclers, enforcement of safe disposal regulations remains weak, largely due to limited government oversight and lack of investment in modern recycling technologies (UNEP, 2023).

- **Plastic Waste Crisis and Policy Responses:** Plastic waste pollution remains a pressing environmental challenge in Lagos, with an estimated 50-60 million used water sachets discarded daily (Adebayo & Adewale, 2024). These sachets, widely used due to limited access to potable water, contribute to clogged drainage systems, urban flooding, and marine pollution, as Lagos generates 2.5 million tonnes of plastic waste annually, much of which ends up in the Lagos Lagoon and Atlantic Ocean (World Bank, 2023). In response to the growing plastic pollution crisis, Nigeria has announced a ban on single-use plastics, set to take effect in January 2025 (The Guardian, 2024). The ban aims to curb plastic dependency, promote eco-friendly alternatives, and encourage local industries to adopt sustainable packaging. However, concerns remain about the nation's enforcement capacity and economic implications. Many small-scale vendors, dependent on plastic packaging, argue that economic hardships and inflation may hinder compliance with the ban (Oyewole, 2024). Additionally, a lack of sufficient recycling infrastructure raises doubts about the government's ability to implement large-scale plastic recovery and alternative packaging initiatives (UNEP, 2023).

- **Policy, Financial, and Climate Change Challenges in Lagos Waste Management:** Lagos, as one of Africa's most rapidly urbanizing cities, faces significant challenges in waste management despite existing regulatory frameworks, financial investments, and environmental concerns. The inefficiencies in policy enforcement, financial constraints,

and climate change impacts have hindered the effectiveness of waste management systems in the city.

- **Policy and Regulatory Challenges:** The Lagos State Environmental Management and Protection Law (2017) were enacted to streamline waste management regulations, promote environmental sustainability, and enforce penalties for improper waste disposal (Lagos State Government, 2017). However, poor enforcement, weak policy coordination, and industry influence on regulations have significantly undermined its effectiveness (Obafemi & Akinyemi, 2023). Despite clear provisions in the Environmental Protection Law, non-compliance remains widespread. Several waste disposal companies and informal collectors continue to dump waste illegally, largely due to a lack of oversight from regulatory bodies like the Lagos Waste Management Authority (LAWMA) (Ajibade, 2024). Additionally, weak enforcement has allowed businesses and industries to evade waste disposal responsibilities, further contributing to environmental pollution. Also, a lack of policy alignment between federal, state, and local government agencies has also created inefficiencies in waste management planning and execution. Private sector interests often influence regulatory decisions, sometimes favouring short-term profit-making over long-term environmental sustainability (Adegbite & Olatunji, 2024). The shift to waste privatization under the Cleaner Lagos Initiative (CLI) in 2017 was meant to improve waste management efficiency, but the abrupt termination of PSP operators and the introduction of Visions cape, a foreign waste management company, led to severe lapses in waste collection (Daily Trust, 2024). This situation underscores the need for more inclusive policymaking, with active participation from local waste collectors, recyclers, and community-based organizations (World Bank, 2023).
- **Financial Constraints in Waste Management:** Waste management is capital-intensive, requiring significant investment in infrastructure, technology, and skilled personnel. However, Lagos struggles with limited funding, inefficient financial planning, and an overreliance on government funding. Managing Lagos' 13,000 to 15,000 tonnes of waste daily requires extensive financial resources, but insufficient budget allocations and limited private sector investment have constrained the expansion of waste processing and recycling facilities (LAWMA, 2024). Many waste collection trucks and processing plants

are out-dated, leading to frequent equipment breakdowns and inefficient service delivery (Wikipedia, 2024). Public-private partnerships (PPPs) have been proposed as a solution to funding gaps, but bureaucratic hurdles, corruption, and lack of transparency continue to hinder successful collaborations (Oyewole & Adetayo, 2023). The failure of the Cleaner Lagos Initiative demonstrated the financial instability of large-scale private sector waste projects, where Visions cape's N89 billion contract collapsed due to poor execution and lack of local stakeholder involvement (The Guardian, 2024). Although LAWMA collects waste management fees from residents and businesses, many refuse to pay due to inconsistent services and weak enforcement of payment policies (Ajibade, 2024). This revenue shortfall affects LAWMA's ability to maintain waste collection trucks, and expand landfill capacity (Obafemi and Akinyemi, 2023).

On-going Innovations and Modern Waste Management Initiatives Towards Low or Zero Waste in Lagos

Lagos faces significant waste management challenges due to its rapid urbanization, high population density, and evolving consumption patterns. However, several innovative waste management initiatives, public-private partnerships, and recycling programs are emerging to drive sustainable solutions toward a low or zero-waste future. These efforts involve government-led reforms, private-sector participation, technological innovations, and community-driven interventions aimed at improving waste collection, processing, and recycling.

- **Public-Private Partnerships and Government-Led Innovations**

In 1997, the Lagos State Government introduced Private Sector Participation (PSP) in waste management to improve efficiency and service delivery. The pilot scheme commenced in two Local Government Areas—Kosofe and Bariga—and was later expanded to other regions by 1999. Despite facing challenges in 2002 due to management issues, the PSP program has grown substantially with the Lagos State government recognizing the need for a more efficient waste management system, through the Lagos Waste Management Authority (LAWMA), has embraced public-private partnerships (PPPs) to modernize waste collection and disposal services. The government has licensed over 350 Private Sector Participants (PSPs) to handle residential, commercial, and industrial waste collection (LAWMA, 2024). To further strengthen this

collaboration, LAWMA signed a five-year agreement with PSP operators in 2021. This agreement aims to boost the operators' confidence and reaffirm the government's commitment to sustainable waste management practices. This collaboration has helped increase waste collection efficiency while creating job opportunities in the sanitation sector.

In addition, the Cleaner Lagos Initiative (CLI), launched in 2017, was designed to restructure solid waste management by improving waste collection infrastructure and deploying compactors to streamline operations. The initiative also introduced mechanized street sweeping and allocated more resources for community sensitization on proper waste disposal (Lagos State Government, 2024). The CLI also led to the creation of approximately 40,000 jobs, including 27,500 direct positions for Community Sanitation Workers, thereby addressing both environmental and unemployment challenges in the state. (https://thenationonlineng.net/lagos-waste-bag-distribution). Another significant innovation is the Lagos Blue Box Program, which promotes source separation of recyclables such as plastics, glass, and paper. Under this program, residents are encouraged to sort their waste before disposal, reducing the volume of waste sent to landfills and increasing recycling rates (LAWMA, 2024).

- **Circular Economy and Recycling Initiatives**

To address the persistent challenge of plastic pollution and electronic waste (e-waste), several organizations and start-ups have introduced circular economy models that transform waste into valuable resources.

- **WeCyclers Initiative:** Founded in 2012, WeCyclers provided incentives for low-income households to recycle waste materials, particularly plastic bottles, aluminium cans, and sachets. Using a bicycle-powered collection system, the initiative encouraged waste segregation at the source and rewards participants with points redeemable for household goods and cash (WeCyclers, 2024).
- **Recycledge:** This Lagos-based company focuses on digital waste management, offering an app-based platform that connects households, businesses, and waste collectors to facilitate efficient waste disposal and recycling. The company ensures that plastic waste

is processed into reusable products, reducing environmental pollution and supporting sustainable development (Recycledge, 2024).

- **FMCG Industry Participation:** Leading Fast-Moving Consumer Goods (FMCG) companies such as Nestlé, Unilever, and Coca-Cola have partnered with waste management stakeholders to introduce Extended Producer Responsibility (EPR) schemes. These programs mandate that producers take responsibility for post-consumer waste, especially plastic packaging. Coca-Cola's "World Without Waste" initiative aims to collect and recycle the equivalent of 100% of its packaging by 2030 (Coca-Cola Nigeria, 2024).

- **Lagos State Plastic Recycling Bank:** LAWMA has also introduced a plastic buyback program where residents can exchange plastic waste for cash or household items. This program incentivizes recycling while reducing the amount of plastic waste clogging drainage systems and polluting water bodies (LAWMA, 2024).

❖ **Waste-to-Energy and Composting Innovations**

Lagos is also investing in waste-to-energy technologies to convert organic waste into biogas and electricity.

- **Ikosi Market Biogas Project:** The Lagos State Government, in collaboration with the United Nations Industrial Development Organization (UNIDO), launched a biogas pilot project at Ikosi Market. This initiative processes organic waste from food vendors and traders into clean energy, reducing reliance on fossil fuels and mitigating greenhouse gas emissions (UNIDO, 2024).

- **LAWMA Organic Waste Composting:** To promote sustainable agriculture and reduce landfill waste, LAWMA is working on developing composting facilities that convert organic waste into fertilizers. This initiative not only helps manage food waste but also supports urban farming initiatives across the state (LAWMA, 2024). The development of composting facility and biogas production are in line with the sustainability agenda of the state government.

❖ **Smart Waste Management and Digital Innovations**

Technology-driven solutions are increasingly being adopted to optimize waste collection and monitoring in Lagos. These include;

- Smart Bins and Waste Sensors: LAWMA has begun piloting smart waste bins equipped with sensors that notify collection agencies when they are full. This real-time monitoring system enhances operational efficiency and prevents overflowing bins in public spaces (LAWMA, 2024).
- Mobile Payment and Billing Systems: To streamline waste collection payments, digital platforms such as the PSP Lagos app and bank-integrated payment portals have been introduced. These platforms allow residents and businesses to track their waste bills, make payments online, and report collection issues (PSP Lagos, 2024).
- Geo-Mapping for Waste Collection Optimization: LAWMA and private waste collection firms are leveraging geospatial data and artificial intelligence to map high-waste-generation areas, ensuring more strategic deployment of waste collection trucks and personnel (LAWMA, 2024).

Lagos State Government Policies on Greenhouse Gas (GHG) Mitigation, Recycling, and Municipal Solid Waste (MSW) Management

Lagos State faces significant challenges in managing greenhouse gas (GHG) emissions and municipal solid waste (MSW). The state's rapid urbanization and population growth have necessitated comprehensive policies targeting GHG mitigation, recycling, and overall waste management. This research delves into Lagos State's governmental strategies addressing methane and carbon dioxide emissions, recycling initiatives, and general MSW management.

❖ **Methane Emission Reduction policies**

Methane is a potent GHG, with a global warming potential approximately 25 times greater than CO_2 over a 100-year period (IPCC, 2021). In Lagos, methane emissions primarily stem from the decomposition of organic waste in landfills. To address this issue, the Lagos State Government has implemented several measures, including landfill gas recovery projects and fumigation of dumpsites.

❖ **Landfill Gas Recovery Projects**

One of the methane mitigation strategies that the Lagos government is deploying is landfill gas recovery. In 2011, LAWMA received a grant from the Global Methane Initiative (GMI) to assess the feasibility of capturing landfill gas at the Abule Egba and Solous landfills (GMI, 2012). The assessment identified the potential for methane capture and utilization for electricity generation. As a result, LAWMA initiated a landfill gas-to-energy project, which collects and processes landfill methane to provide electricity to nearby communities. The project aligns with the state's broader goal of reducing reliance on fossil fuels and mitigating the environmental impact of open waste dumping.

Furthermore, the Olusosun landfill, one of the largest in Africa, has been identified as a potential site for methane capture and energy recovery. The landfill, which receives approximately 10,000 tonnes of waste daily, emits substantial amounts of methane (LAWMA, 2023). The government has proposed converting Olusosun into an engineered landfill with methane capture systems, a strategy that is expected to significantly reduce emissions while generating renewable energy.

- **Dumpsite Fumigation and Closure Programs**

In addition to landfill gas recovery, LAWMA has implemented dumpsite fumigation programs to control methane emissions and improve air quality. In February 2022, LAWMA commenced the fumigation of dumpsites across the state, starting with the Igando-Solous dumpsite. This initiative aims to suppress methane release by reducing the decomposition of organic waste under anaerobic conditions (LAWMA, 2022). Moreover, Lagos State has initiated the progressive closure of open dumpsites and their replacement with sanitary landfills. Open dumps are a major source of uncontrolled methane emissions due to the absence of proper waste containment and gas collection systems. The 2023 Lagos State Environmental Protection Plan includes provisions for transitioning from open dumping to waste treatment facilities equipped with gas capture and leachate management systems (LASEPA, 2023).

- **Carbon Dioxide Emission Reduction**

While methane is the most concerning GHG from waste, carbon dioxide (CO_2) emissions also contribute to climate change. CO_2 emissions from waste management primarily arise from waste incineration, transportation of waste, and organic waste decomposition. Lagos State has adopted

multiple strategies to address these emissions, with a focus on recycling programs and sustainable transportation.

❖ **Promotion of Recycling**

Recycling reduces CO_2 emissions by diverting waste from incineration and reducing the demand for virgin raw materials, which require energy-intensive processing. Lagos State has taken several steps to promote recycling, including:

- **The Lagos Blue Box Program**: Launched by LAWMA in 2018, the **Blue Box Program** encourages households to separate recyclables such as plastics, paper, and glass from general waste. By reducing landfill waste, the program minimizes methane emissions while decreasing CO_2 emissions associated with incineration (LAWMA, 2021).
- **Waste-to-Wealth Initiatives**: LAWMA has supported businesses and start-ups that convert waste into valuable products. For instance, **Wecyclers**, a Lagos-based recycling company, incentivizes low-income communities to collect and trade recyclable waste. The collected materials are processed into raw materials for manufacturing, reducing emissions from both waste disposal and industrial production (Wecyclers, 2023).
- **Plastic Waste Reduction Programs**: Lagos produces 50-60 million used water sachets daily, many of which end up in landfills or the environment, contributing to plastic pollution and CO_2 emissions from decomposition and incineration. The state has introduced policies to ban single-use plastics, set to take effect in January 2025. While implementation challenges remain, this policy aims to drastically cut CO_2 emissions from plastic waste disposal (The Guardian, 2024).

❖ **Sustainable Transportation Initiatives**

Transportation accounts for a significant portion of CO_2 emissions in Lagos, particularly in waste collection and disposal. To address this, the state government has implemented:

- **Fleet Modernization for Waste Collection**: LAWMA has begun transitioning from older, diesel-powered waste collection trucks to compressed natural gas (CNG) vehicles, which emit significantly less CO_2. The agency has also adopted route optimization technologies to improve collection efficiency and reduce fuel consumption (LAWMA, 2023).
- **Integration of Waste Collection with Public Transport**: As part of Lagos urban planning initiatives, the government is exploring ways to incorporate waste logistics into the Bus Rapid Transit (BRT) system to reduce emissions from standalone waste collection vehicles (Lagos State Government, 2023).
- **Encouraging Non-Motorized Waste Collection**: Organizations like Wecyclers use bicycle-powered waste collection in informal settlements, reducing CO_2 emissions while providing job opportunities for waste collectors (Wecyclers, 2023).

❖ **The Lagos State C40 Cities Climate Leadership Groups'**

In 2008, Lagos State established a dedicated climate change unit (now department) within the Ministry of the Environment and Water Resources. This department has led the development and implementation of a range of cli mate change plans and strategies in the State. In 2018, Lagos State signed up to the C40 Cities Climate Leadership Group's Deadline 2020 and committed to developing a Climate Action Plan (CAP) aligned with the goals of the Paris Agreement on Climate Change, with the ultimate goal of achieving carbon neutrality by 2050. The Climate Change Department has led the development of this CAP and will also lead its implementation. Under this programme, Lagos joined C40 Cities around the world in committing to the development and implementation of an inclusive and ambitious Climate Action Plan (CAP) in line with the goals of the Paris Agreement, which will result in a zero-carbon Lagos by year 2050. Prior to its current work with C40, Lagos had developed a Climate Change Policy and Action Plan with support from United Nations Development Program (UNDP). As part of its CAP Programme, C40 Cities provided significant technical expertise to align the previously developed Climate Action Plan with the ambitions of the Paris Agreement to limit the global average tempera ture increase to below 1.5^0C. The CAP builds on earlier climate change strategies for Lagos State to deliver a package of measures that, if implemented successfully, will

set Lagos on a pathway towards carbon neutrality by 2050. The aims of the CAP are aligned with the goals of the Paris Agreement on Climate Change, in particular the ambition to limit average global temperature rise to 1.5°C. Besides contributing to climate change mitigation by reducing emissions, the CAP also aims to enhance the resilience of Lagos's population, economy and infrastructure to the impacts of climate change. It further seeks to maximise the co-benefits of climate actions in support of the State's vision to create a cleaner, greener, healthier, stable and more prosperous Lagos in the face of a changing climate. The development process of the CAP was underpinned by a comprehen sive Stakeholder Engagement Plan that aimed to raise awareness of cli mate challenges and solutions, collect input at various stages of CAP devel opment, foster broad ownership of the CAP among stakeholders and ensure that wider benefits of climate action are distributed equitably. Stakeholders were given the opportunity to contribute to the CAP through workshops and a broad engagement campaign that included household surveys. The State is committed to keeping relevant stake holders involved throughout the CAP's implementation

10.3. Situation in Jos, Plateau State

Jos metropolis has over the years witnessed rapid urbanization and population growth which has led to increased waste generation, highlighting the critical need for effective waste management practices. Available study shows that an estimated 221 tons of waste is generated per day in Jos metropolis with a projected increase to 299 tons by 2032, reflecting a 35.29% growth in a decade (Alubo et al., 2023). Following the establishment of the FEPA decree in 1988, it was expected that state governments would establish a State Environmental Protection Agency and formulate their own policies in order to further address environmental issues within their jurisdiction, hence the creation of Plateau Environmental Protection and Sanitation Agency (PEPSA). PEPSA was established in 2000 and they are responsible for the collection and disposal of waste. The Plateau State Environmental Sanitation Edict of 2007 is the most current strategy document that addresses waste management and environmental pollution. There are now no private waste management collection companies operating in Jos. Notwithstanding, PEPSA have been at the forefront of MSW management, providing public bins, periodically colleting waste from these bins and disposing them at designated dumpsite at Dong village outside Jos town, Plateau State.

Specific responsibilities of PEPSA

Municipal solid waste management in Plateau State falls under the statutory function of the Plateau Environmental Protection and Sanitation Agency (PEPSA).

- Remove, transport and dispose of domestic, commercial and industrial waste;
- Clear and maintain public drainage facilities, street cleaning and clearing of abandoned vehicles;
- Register private waste collection companies,
- Prepare and periodically up-date the master plan of waste collection and disposal in the city, approve and monitor all disposal systems in the city;
- Assess recycling as a waste management option for industries and government agencies.
- Establish and recommend the basic standard requirements for solid, liquid, gaseous or toxic waste management, provided they do not conflict with, but complement the standards of the FEPA;
- Establish and recommend acceptable safe methods of collection and disposal of hazardous and toxic waste products in Plateau State;
- Educate the general public on the various disposal methods acceptable for domestic and industrial waste products; Initiate environmental protection legislation and keep existing legislations under constant review to reflect the latest discoveries and observations on the subject;
- Organise and mobilise the public to participate actively in regular clean-up exercises and beautification of their environments.

Municipal Solid Waste Storage, Collection and Transportation

There are no private companies operating that collect waste, hence PEPSA is responsible for collecting waste from municipalities, and their responsibilities include managing waste from households, offices, street, industries, hospitals, markets and institutions. To achieve this task, the Agency provided containers/bins (1.1 m^3 metal bins) available at strategic public locations within the municipalities (Plates 43 & 44). Households are not provided with waste storage containers, hence they store their waste in disposable polythene bags or other sizable containers like metal buckets, baskets, and then transport these waste in their private vehicles to designated waste bins. Informal waste collectors also operate at PEPSA designated dumpsites where they receive waste bags from individuals, then separate out recyclable materials and leave behind unwanted

degradable waste. Additionally, informal sector collection workers operate house-to-house collection services. These informal waste pickers also separate out recyclable materials and dump unwanted degradable waste around the area. As a result, such informal collectors are officially banned from certain areas, and their carts are regularly impounded by the authorities (Gwom et al., 2014). Informal collection and transportation of waste is both labour and capital intensive. Manual collection equipment used by informal sector waste collectors includes push carts, wheel barrows and pedal tricycles. Other basic implements used by the informal sector (for waste sorting) include hand-rakes, shovels and iron sorting rods.

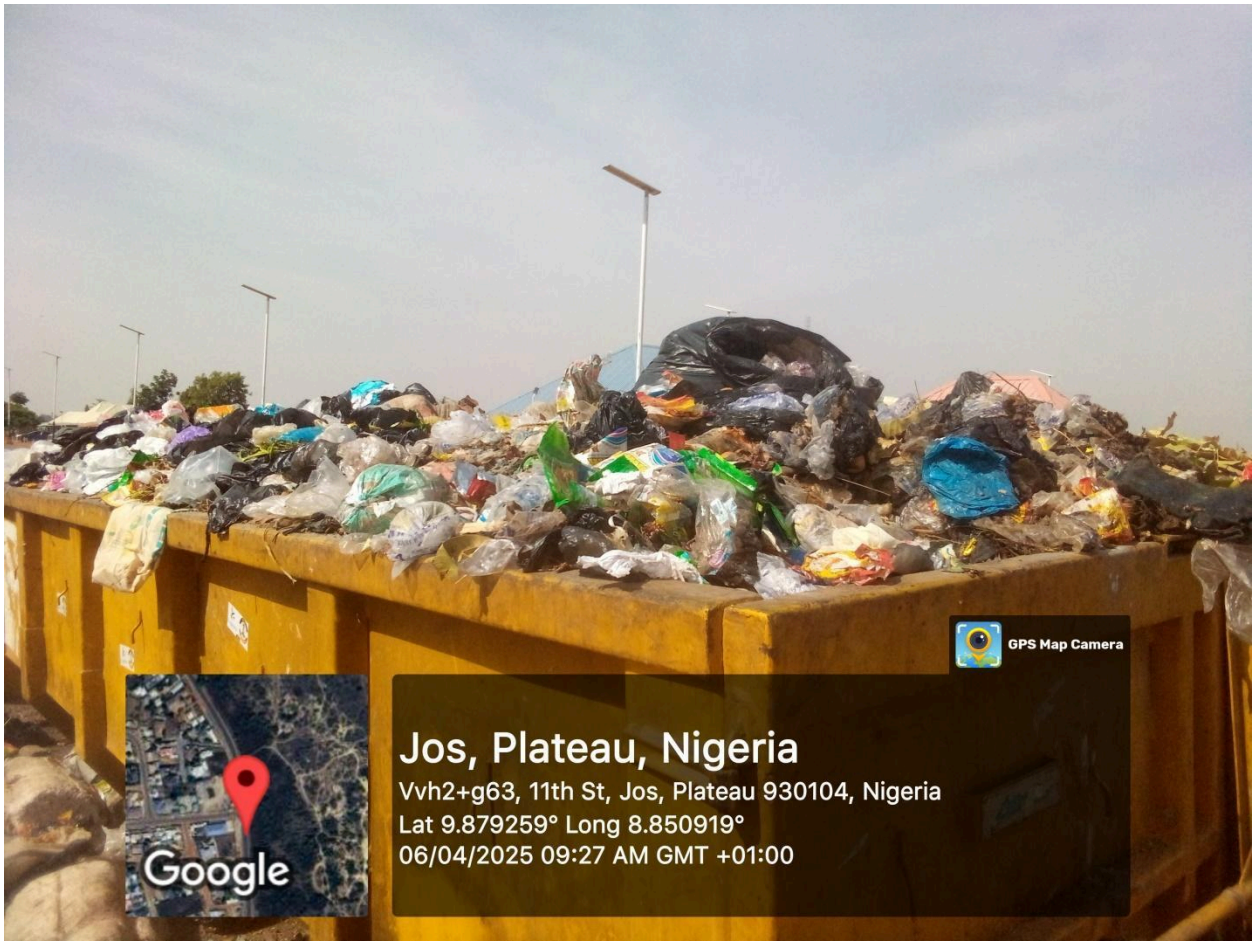


Plate 43: A typical example of Public Waste bin provided by PEPSA in Jos north, Plateau State

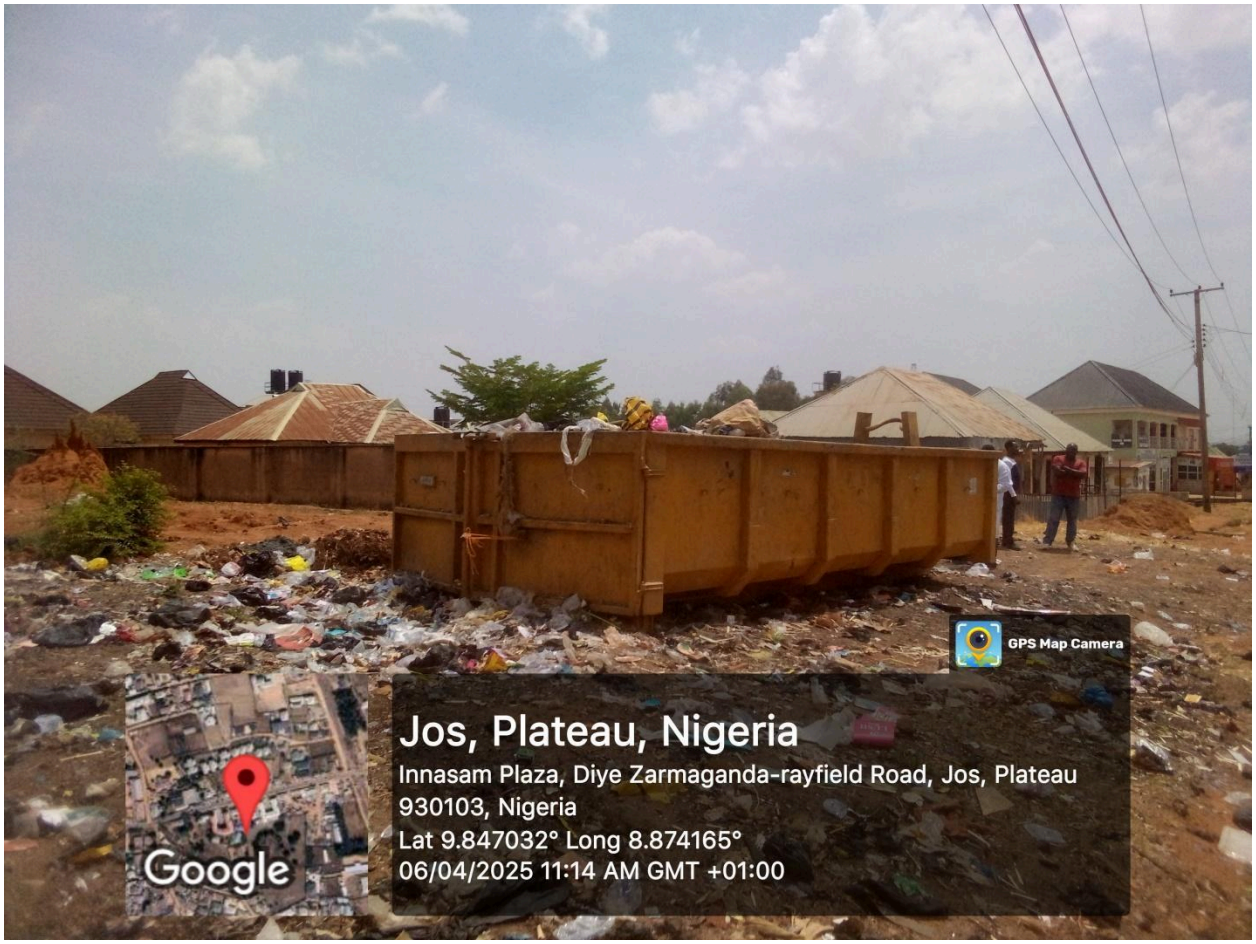


Plate 44: A typical example of Public Waste bin provided by PEPSA in Jos south, Plateau State

PEPSA is a public agency and solely undertake all collections, especially as public–private partnerships in solid waste management have been in practice in the State. However, public–private partnership initiatives in MSW management were adopted in Plateau State from 2005-2007 (Osesienemo, 2008). Under this initiative, twenty-four (24) private waste companies were registered with PEPSA, and these companies were then contracted to deliver the collection service for 25 different zones (with one operator handling two zones). The role of the companies was to collect and transport all waste from zones under their responsibility, and to dump it at designated dumpsites approved by the Ministry of Environment, under the supervision of PEPSA. Unfortunately, this public–private partnership initiative was not sustained due to political interference leading to non-compliance of these companies to the Terms of reference of contract agreement. As a result, in 2007 the State government terminated all contracts with all private companies with regards to MSW management in the State.

Municipal Solid Waste Disposal in Jos

There are two types of open dumping in Jos. The first is the PEPSA organised/formal arrangement involving the collection of waste from public waste containers (bins provided by PEPSA), and second is the indiscriminate dumping of waste in open spaces, drains and abandoned mine sites. Solid waste from the formal collection system (PEPSA) is usually transported to a single dumpsite at Dong, a suburb. The Illegal and indiscriminate disposal of waste is also prevalent in Jos town. It is common practice to find piles of solid waste along roads, underneath bridges, in culverts and drainage channels and other open spaces (Plates 45- 47). At the moment, there are no sanitary landfills in Jos. Some researchers have attributed illegal/ indiscriminate dumpsites in Jos to the inadequate number of public waste containers or non-collection of overflowing public bins so people have no option other than to dump the waste, non-availability of designated dumpsites, and the use of open trucks leading to waste being blown out (Daffi & Kassam 2013; Musa et al. 2008).

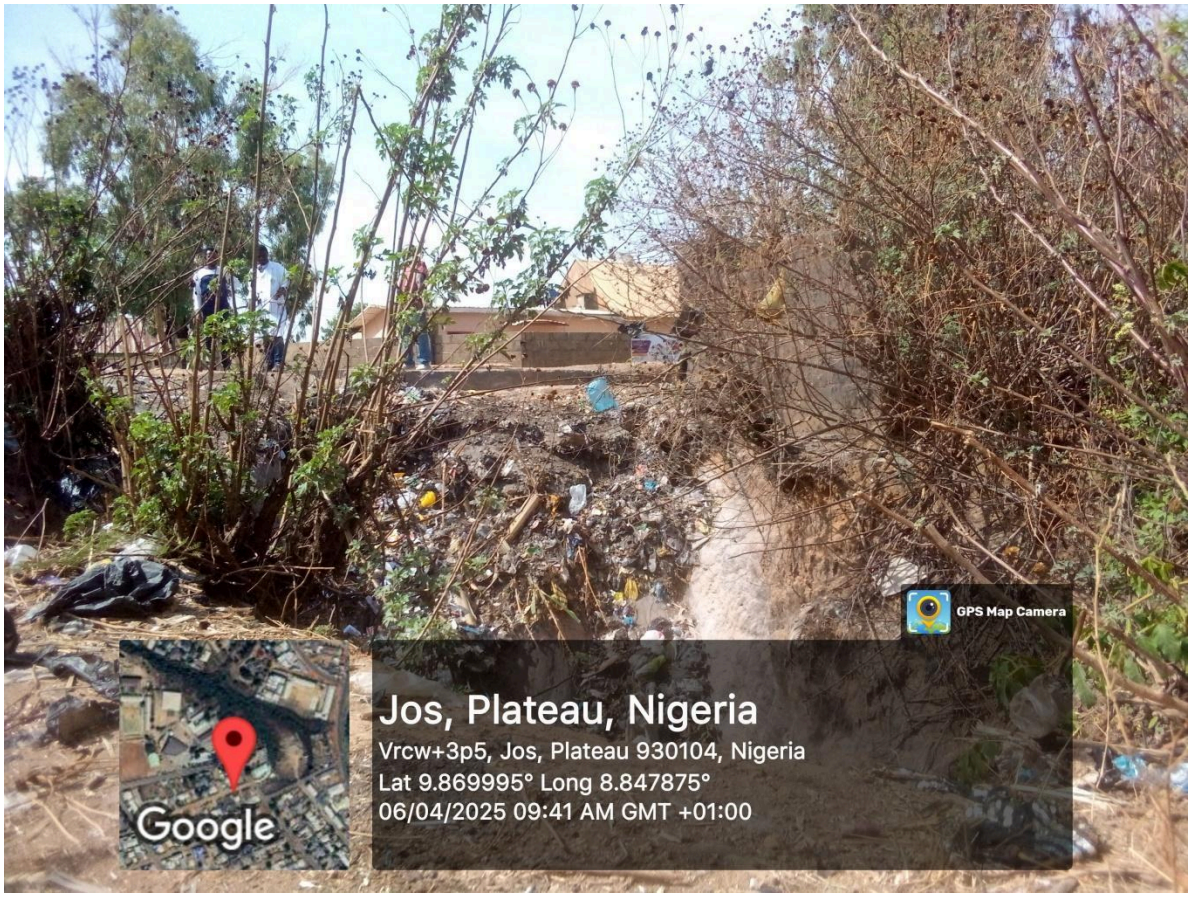


Plate 45: Indiscriminate dumping of waste into abandoned mine site at low housing estate in Jos, Plateau State

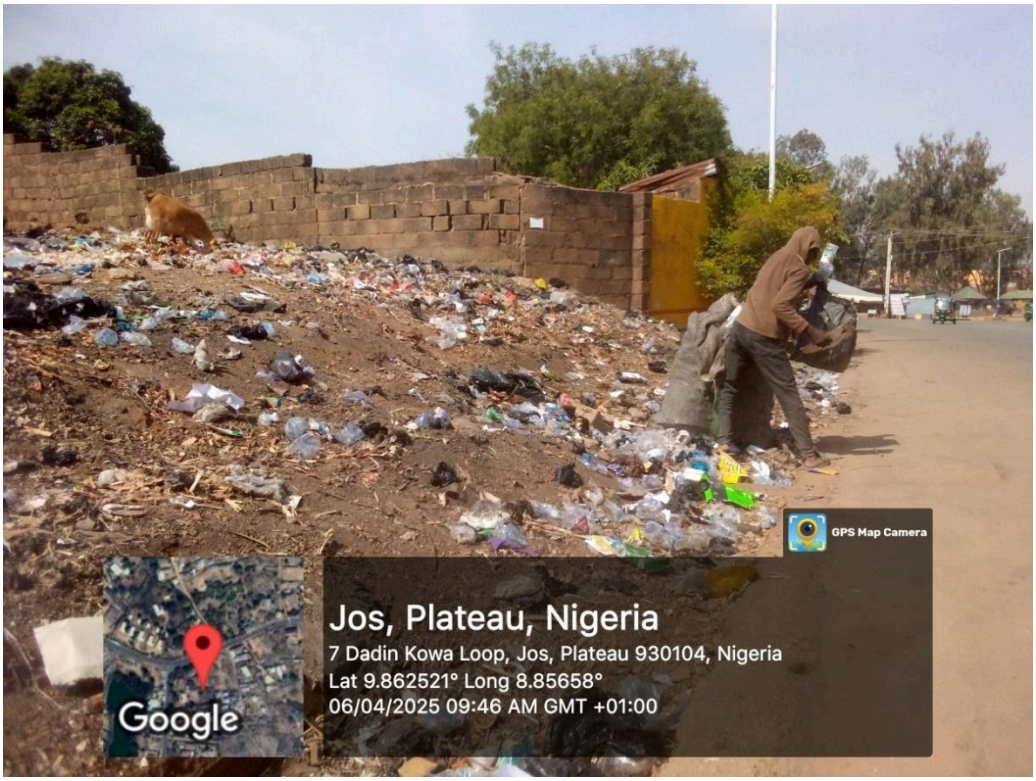


Plate 46: Indiscriminate dumpsite along Dadin Kowa Loop, Jos, Plateau State

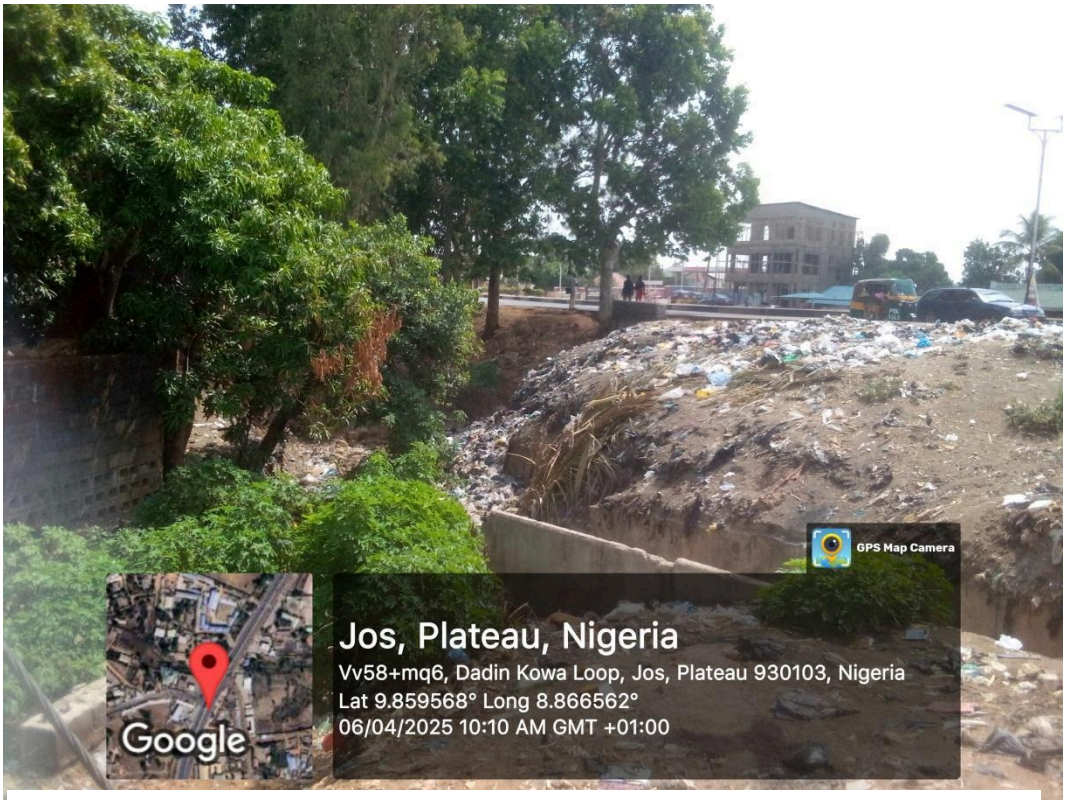


Plate 47: Indiscriminate dumping of waste into abandoned mine site at Dadin Kowa Loop, Jos, Plateau State

Resour

The recyclable content of waste in Jos are mostly plastic materials, textiles, metals/ cans, bottled and furniture. Material recovery is carried out by the informal sector. Material recovery takes place at designated dumpsites, illegal dumpsites and house-to-house material collection. At the dumpsites, most recovery is carried out by segregation from mixed waste (Plates 48 & 49). Such sorting is undertaken by the informal sector collectors from their carts; by the collection crew from waste vehicles; and by scavengers, both from street bins and at the dumpsite. Informal waste pickers normally have no formal education, vocational training or access to appropriate equipment and do not normally have alternative employment opportunities in the formal sector. The scavengers and other informal sector recyclers generally sell their recovered materials to middlemen, who in turn sell to small and large-scale processing and manufacturing industries. Interview with informal waste pickers shows that collected glass is processed and recycled locally as cullet for use in the glass industry; while bottles are cleaned and reused as syrup, drinks and juice containers; the bases of broken bottles are sold to small scale industries that cut and polish the glass to manufacture items such as ash trays and candle holders. Recovered

plastics on the hand are compressed, arranged in bales and transported to Kano State for primary, secondary, tertiary and quaternary recycling.

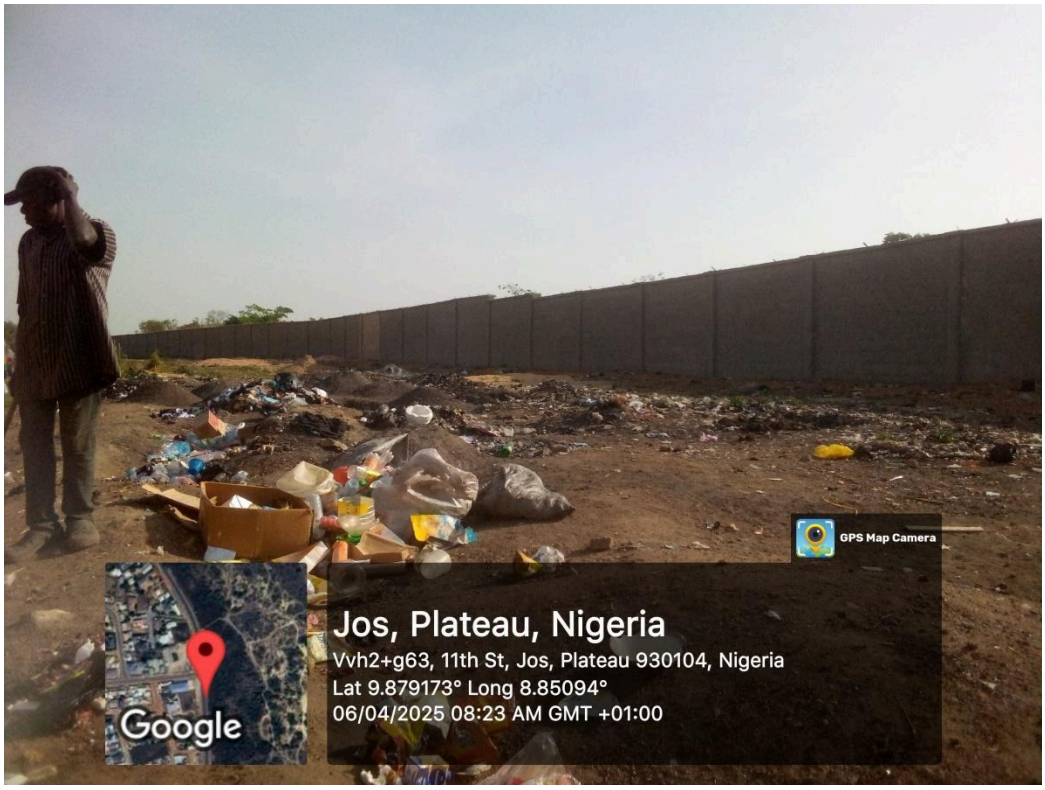


Plate 48: Material sorting process by informal waste pickers at 11th St Jos, Plateau State

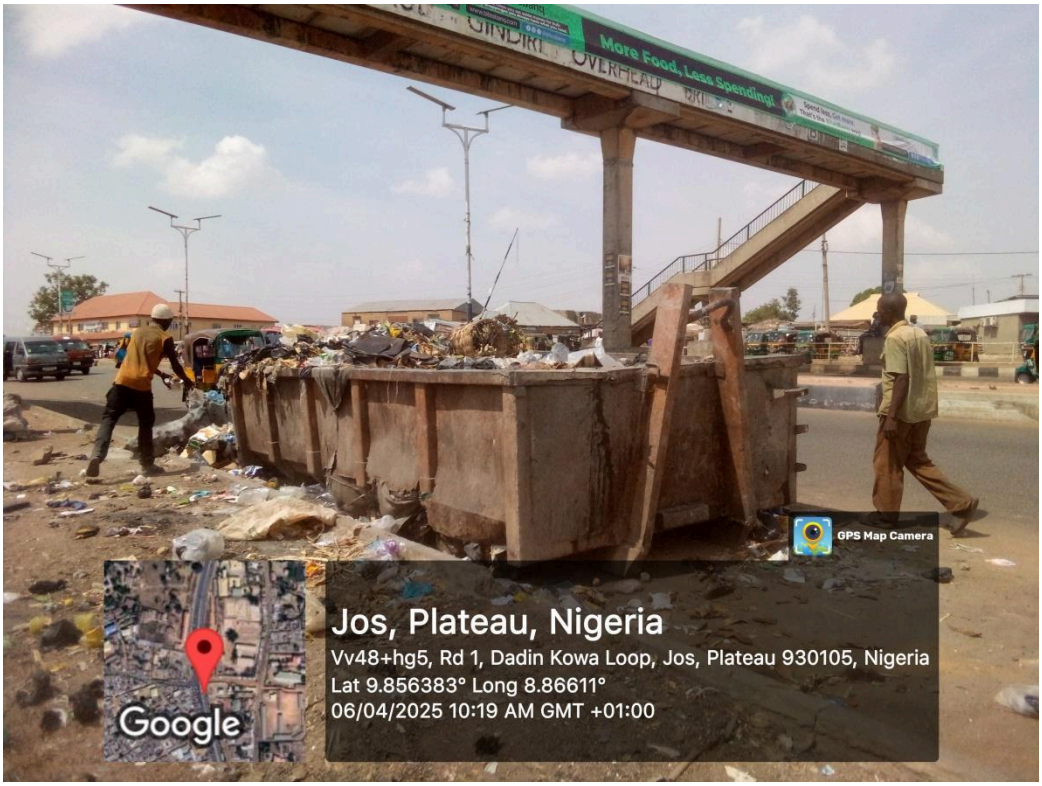


Plate 49: Informal waste pickers carrying out material sorting process at a designated dumpsite Jos, Plateau State

Resource Recovery for Soil Enrichment in Jos

Farming in Jos, Plateau State, like much of Nigeria, has historically been subsistence based. In fact Plateau State is regarded as the home of vegetables in Nigeria. Most farmers in the state are known to use urban waste as a fertiliser on their farms as against chemical fertiliser. Farmers sometimes pay to have waste dumped on their farmland, while land owners pay to have it and use it to reclaim their land (Yakubu, 2017, oral interview, 2025). In previous studies, Lewcock (1994) and Lewcock (1995) indicated that urban waste was sought after by farmers, and the practice of using urban waste has been documented in Jos by Pasquini (2002), Pasquini (2006) and Pasquini & Harris (2004). This waste is not composted but rather burnt and applied directly as ash with other fertilisers (Alexander, 1986; Phillips-Howard & Kidd, 1991). The process of using organic waste in Jos was further explained by Yakubu (2017) and by farmers during this survey as follows " the waste collected from the municipality (PEPSA) is delivered to their farms. The farmers then spread it to dry, and then burn it. The hard non-combustible waste such as glass bottles and metals are raked and removed for disposal while the ash from the waste is

spread on the farm to fertilise it. Plates 50 and 51 show heaps of ash from burnt waste on a farm in Jos north waiting to be spread. Pasquini (2002) further reported that during the late 1970s, farmers switched over from chemical fertiliser to using urban waste ash for farming in Jos. Pasquini & Harris (2004) also pointed out the benefits of using ash are that it is a rich source of nutrients for crops, it raises the pH of the soil, and it also helps in alleviating waste disposal problems. However burring of waste to turn them to fertiliser has implication for air pollution and more so the ash from burnt from waste may lack necessary microorganisms that support soil fertility.

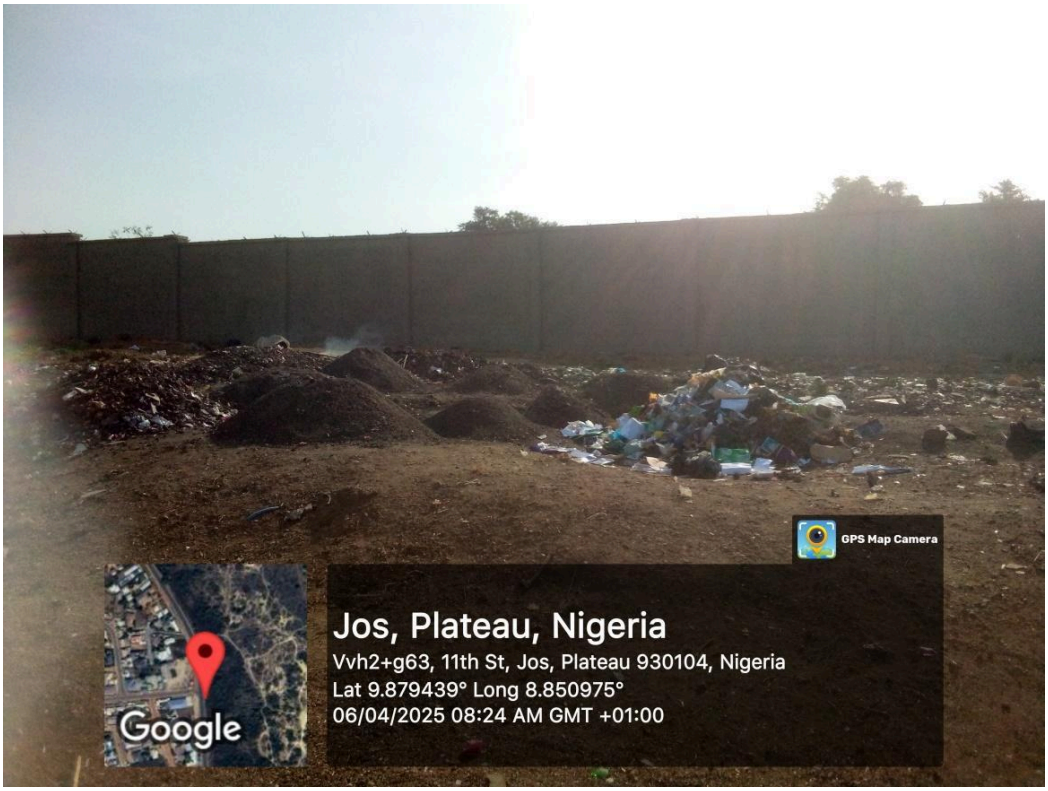


Plate 50: Ash from burnt waste material awaiting for use in farm in Jos north

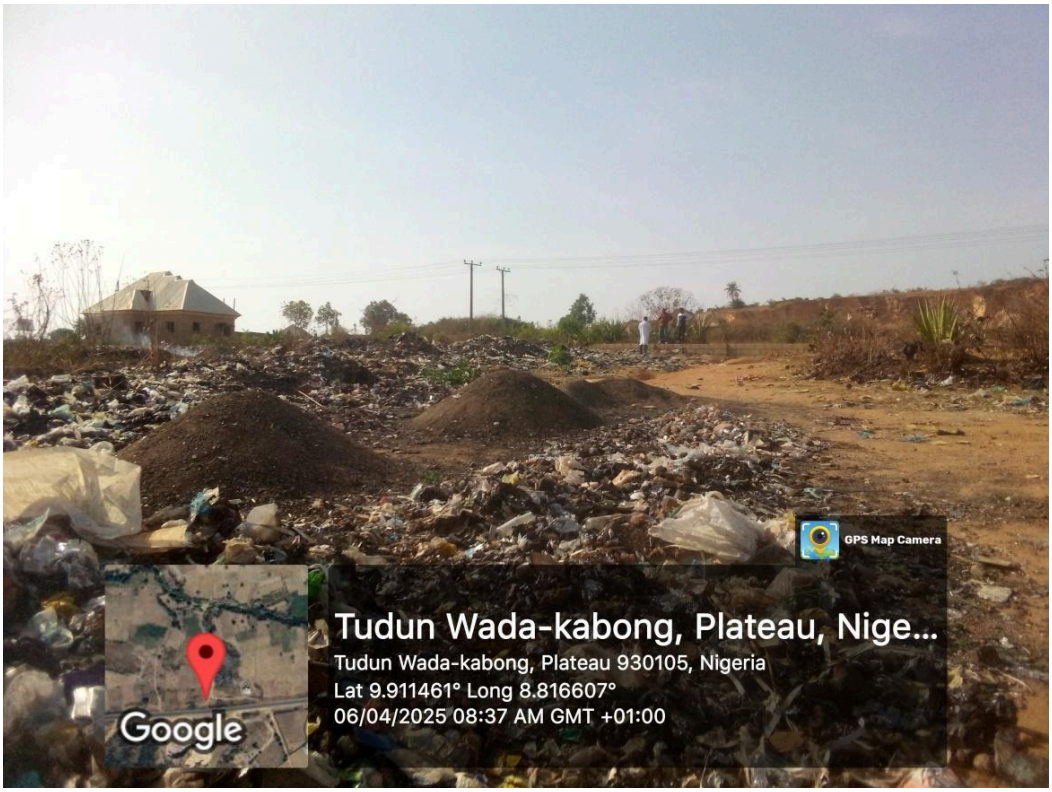


Plate 51: Ash from burnt waste material awaiting for use in farm in Tudun Wada-Kabong, Jos north

Challenges of Waste Management in Jos

The unprecedented population growth coupled with developmental activities in Jos has led to urbanization. Hence, the city of Jos in Plateau State is experiencing the effects of population expansion including, insufficient income, unemployment and environmental degradation improper MSW management. The waste management issues in the state can easily be noticed from the overflowing of public waste bins, an indication that the imbalance between generation and capacity of PEPSA to effectively manage these waste.

Insufficient trucks for waste collection: These challenges ranged from insufficient trucks for waste collection, insufficient provision of public waste containers and non-provision of permanently designated waste dumpsites, to insufficient budgetary allocation, insufficient staffing, role conflict with other agencies, and non-enforcement of waste regulations.

Institutional constraint: There is also the issue of institutional constraint. Several agencies have been created at the state level that is involved at least partially in solid waste management (Onibokun, 1999). Such agencies at the state level include – Plateau Environmental Protection

and Sanitation Agency (PEPSA), special environmental task force etc. However, there are often no clear roles/functions of the various state and local government agencies defined in relation to municipal solid waste management and also no single agency or committee designated to coordinate their projects and activities. The local government environmental department has the responsibility of picking up and transportation of solid waste from public place to dumpsites (PEPSA, 2013).

Coordination issues among the relevant ministries: The PEPSA also has the mandate to pick up and transport solid waste to the dumpsite. However there is no body coordinating these activities. The lack of coordination among the relevant ministries and agencies often results in duplication of efforts, wastage of resources, and un-sustainability of overall municipal solid waste management programs.

Weak legislation for municipal: The lack of effective legislation for municipal solid waste management is partially responsible for the roles/functions of the relevant federal, state and local government agencies not being clearly defined and the lack of coordination among them.

10.4. The Situation FCT, Abuja

The Abuja Environmental Protection Board (AEPB) was established by the AEPB Act No. 10 of 1997. The Board is the Regulatory Body statutorily charged with the responsibility for the protection and management of the FCT Environment. AEPB is administered by a governing board chaired by the representative of the FCT Minister and 15 other members, including the Director/Chief Executive Officer who implements the policies of the governing Board in line with the Agency's objectives. AEPB consist of about 8 departments, public relations, accounts and finance, environmental health, administration and supplies, enforcement and monitoring, environmental monitoring, planning, research and statistics, environmental conservation waste management and sanitation department; The Board also has units such as solid waste, clinical waste and liquid waste. The solid waste, clinical waste and liquid waste management Units are the responsibility for the waste management and sanitation department.

Specific Functions of AEPB:

- To secure a clean and healthy environment for the wellbeing of FCT residents.

- ❖ To conserve the environment and its natural resources for the benefit of present and future FCT generations.
- ❖ To minimise the impact of physical development on the ecosystem of the country's new Federal Capital Territory (sustainable development).
- ❖ To raise public aware and promote understanding of essential linkages between environment and development.

MSW Storage and Collection in the FCT:

Abuja Environmental Protection Board has specific waste storage containers distributed at public locations. The waste storage containers vary in type and sizes. For example, residential, commercial areas, housing complexes and offices have different sizes and specific types designated for their usage (Plates 52 & 53). The waste storage container range from; 10L, 50L, 100L, 240L and more. The smaller sizes come in hard plastic while the larger storage containers are made of metal. The location of the storage container is based on building layout and type of housing unit. Municipal Solid waste collection is contracted to private companies. Collections in some locations are periodically consistent, while in others it is not, a situation which results in overflowing and littering of waste on the ground. Influencing factors such as insufficient collection vehicles, an insufficient number of staff, unplanned neighbourhoods and high costs. House to house waste collection is carried out with home owners being responsible for placing their waste bins in front of their houses. The collectors take the waste bin from the front of each house, roll it to the collection vehicle usually parked in front of the house, empty the waste bin and then place it back to the frontage of the house. For commercial, housing estate, housing complexes and office areas the size of the bins and the collection mode differs. The large metal bins are placed behind the office buildings, housing complexes and estates, commercial complex. The waste in the waste bins are usually collected on weekly basis or as arranged with the Abuja Environmental Protection Board. The waste collected is usually mixed with no segregation at the source. However, informal waste pickers also conduct sorting and material recovery from these waste bins (Plate 54).

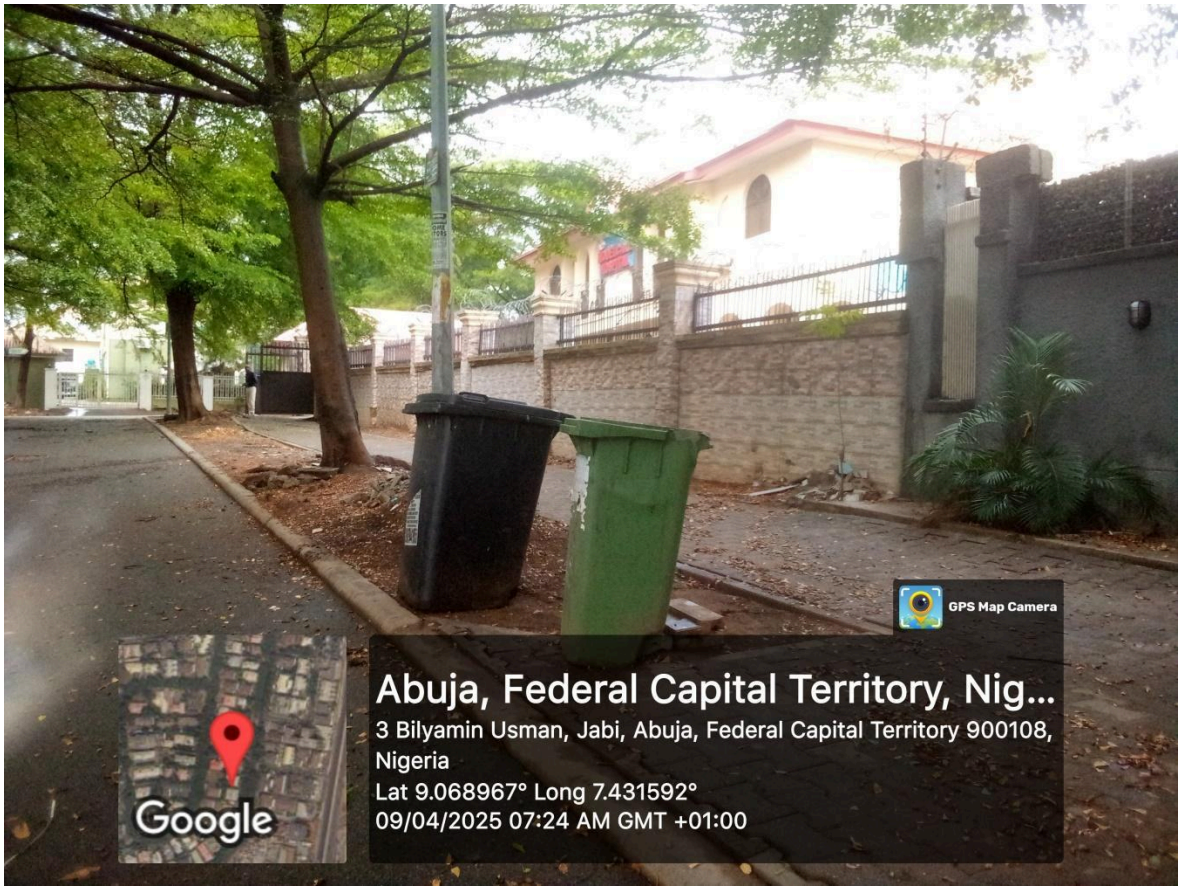


Plate 52: Typical example of waste bin in residential area, FCT, Abuja

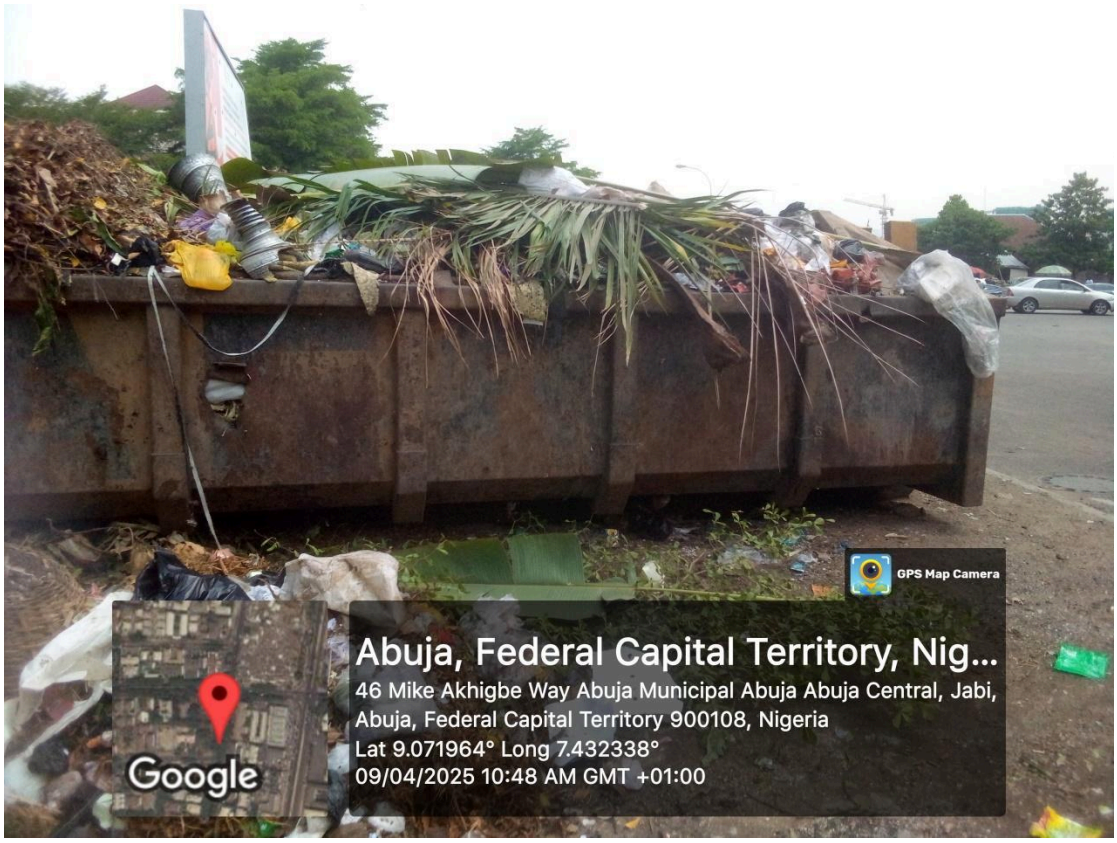


Plate 53: Typical example of AEPB waste bin in residential area, FCT, Abuja

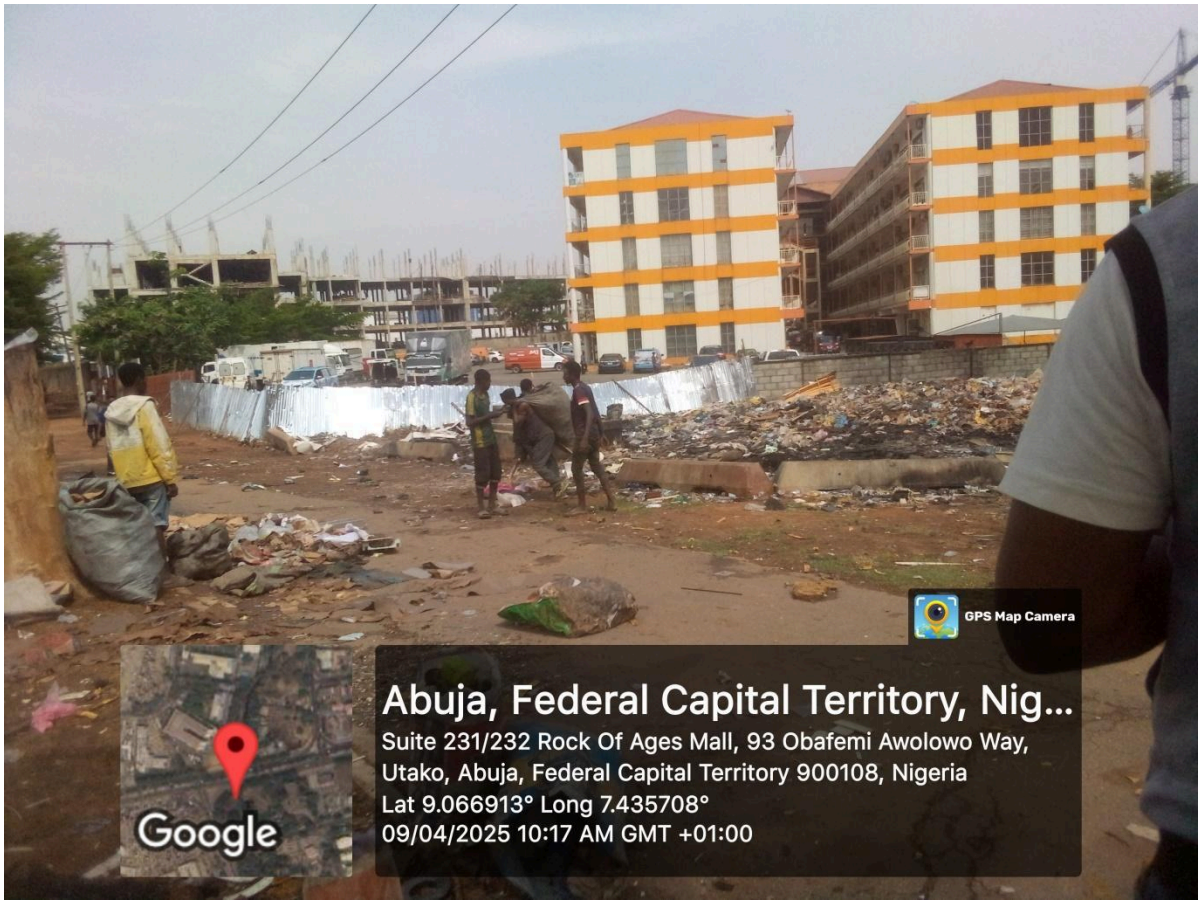


Plate 54: Informal waste pickers sorting waste materials at an illegal dumpsite in FCT, Abuja

MSW disposal in FCT

Majority of the waste composition in FCT, Abuja consist of materials that can be recovered and recycled. However, AEPB is not into material recovery and recycling, rather recovery is usually carried out by the informal sector/scavengers and recycling companies within and outside FCT, Abuja. Plastics, paper, aluminum cans and glass are sort after, and some recycle collectors go from house to house to purchase recyclables from home owners. With regards to disposal, there is presently no sanitary landfill in Abuja. However, the Federal Capital City (FCC) has four landfills. These are Mpape landfill, Gosa landfill, Kubwa and Ajata landfill. Of these four only two are currently operational under the management of AEPB such as Gosa and Ajata landfills.

Mpape Landfill: The Mpape landfill has a depth of approximately 15-20 m and covers about 16 ha of land (Ayuba et al., 2013). Mpape dumpsite was operational from 1989-2005 and operated by the AEPB. The site was a former quarry and after the closure of the quarry it was used as a

dumpsite; open dump. Ayuba et al., (2013) reported that initially in Mpape dumpsite AEPB attempted to operate a controlled dumpsite using intermediate laterite cover (construction waste) and machinery. The landfill has been closed due to exhaustion of space, fire outbreaks and complains from the surrounding residents who live in close proximity to the landfill. Previus study has also reported cases of continuous seepage of leachate from the buried waste that flow to the surface especially during the raining season (Ayuba et al., 2013). During dry season there are continuous burning fires from the buried waste causing heavy air pollution within the area.

Gosa Landfill: Gosa dumpsite is indicated in the Abuja master plan as land laid out for a standard engineered landfill. About 505 ha was marked for a solid waste treatment plant (engineered landfill, treatment facility, composting, recycling and waste to energy plant which is intended to generate 120 megawatts from 3 plants; each generating 40 megawatts) (Ayuba et al., 2013). Operations started in 1980s and the initial operation consisted of: boring a pit, placing waste within and closure. In the 1980s the site was fenced, had an administrative building and access road (Plate 55). Gosa landfill is closed every year during the raining season due to the inaccessibility of the access road into the dumpsite. One of the major issues in Gosa landfill is Indiscriminate tipping by the contractors during the raining season due to inaccessibility to the main tipping point within the landfill as shown in Plate (56). More so, waste segregation and recycling is not practiced in FCT Abuja by AEPB (2012). However, segregation and recycling is carried out by independent scavenges within the landfill as shown in Plates (57-59) . The scavengers sort out the waste components after the contractors tip the waste. They sell the collected items in bulk to companies located in different parts of Nigeria.

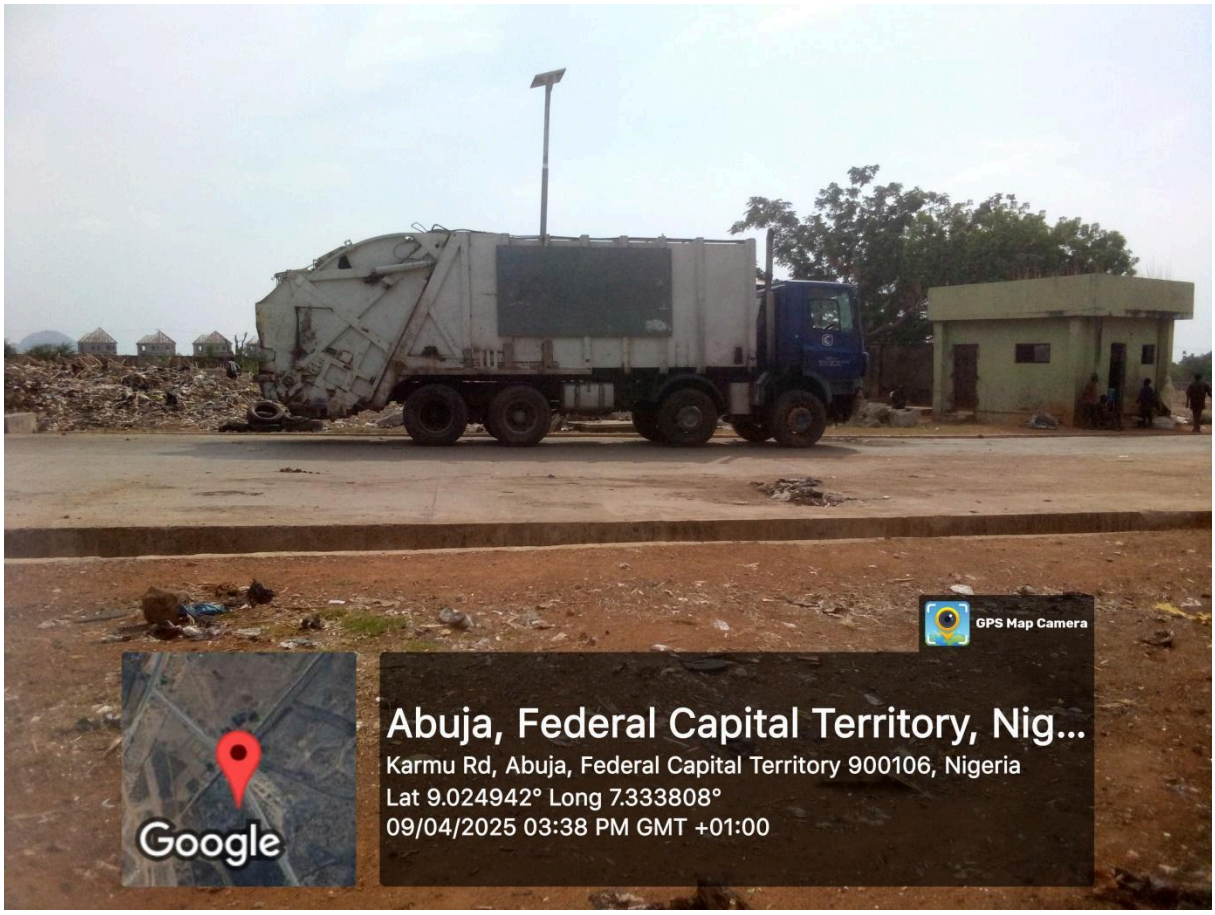


Plate 55: Access road inside Gosa dumpsite, FCT, Abuja

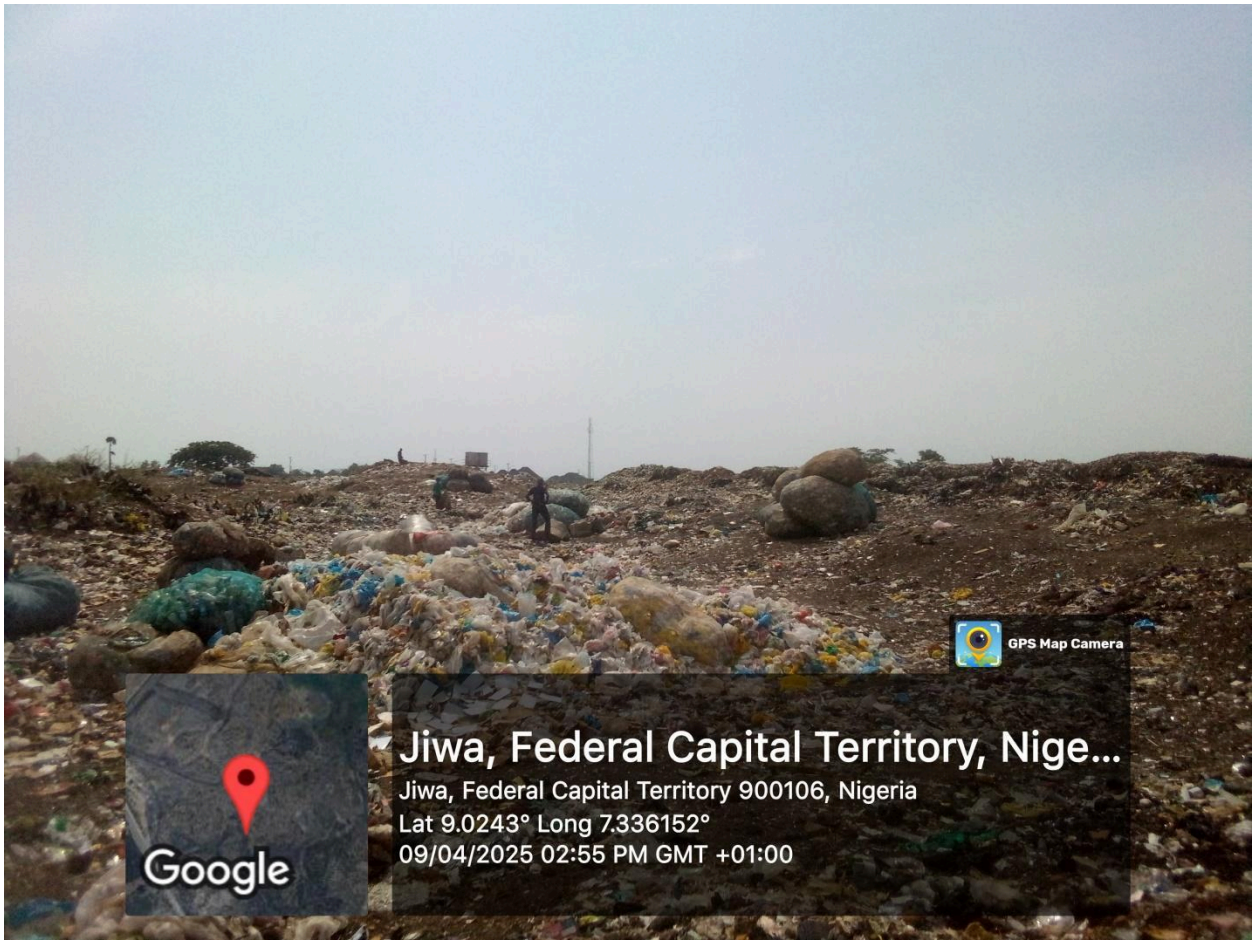


Plate 56: Indiscriminate tipping of waste on road leading to gosa dumpsite by the contractor is a major setback in FCT, Abuja

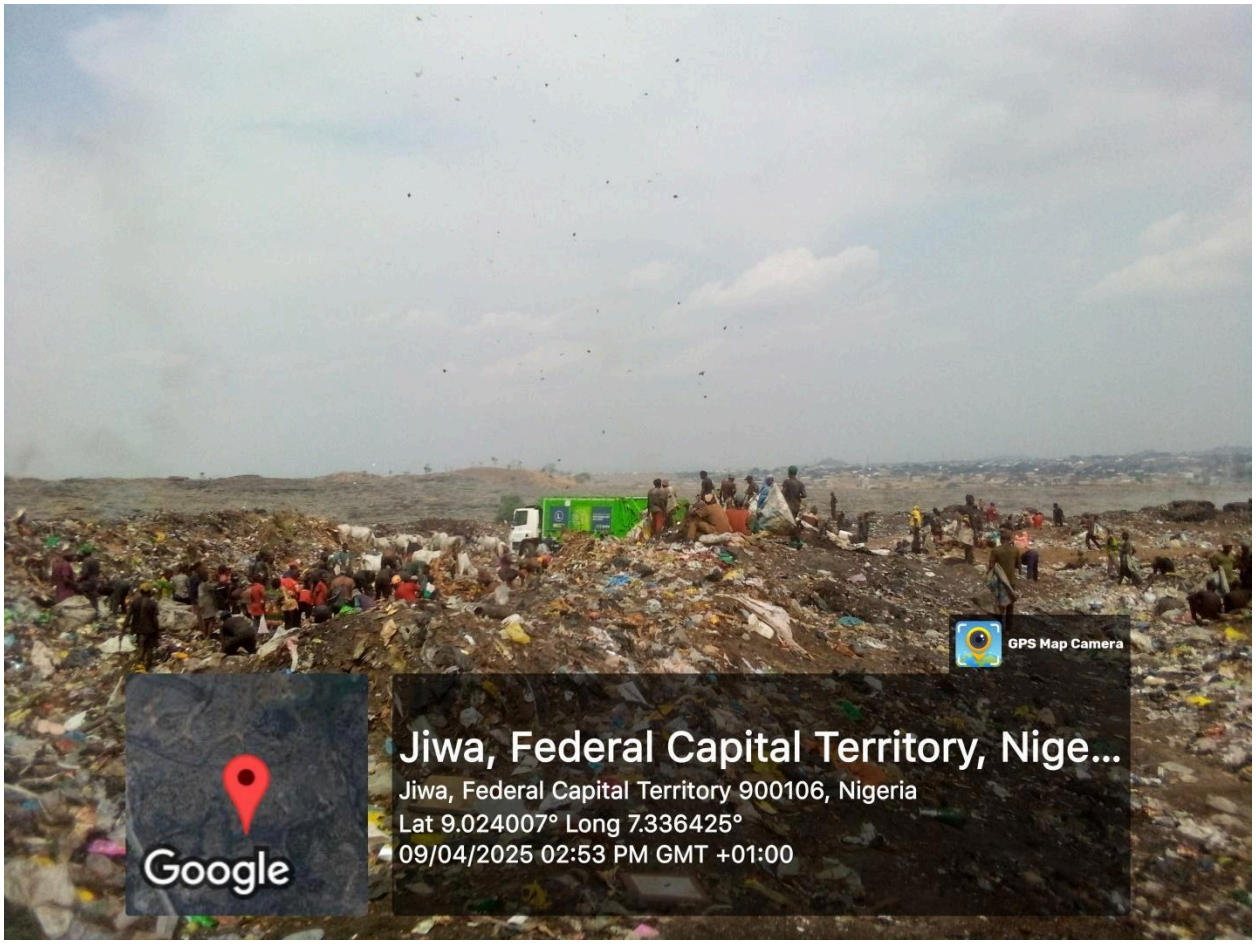


Plate 57: Informal waste pickers at Gosa dumpsite, FCT, Abuja

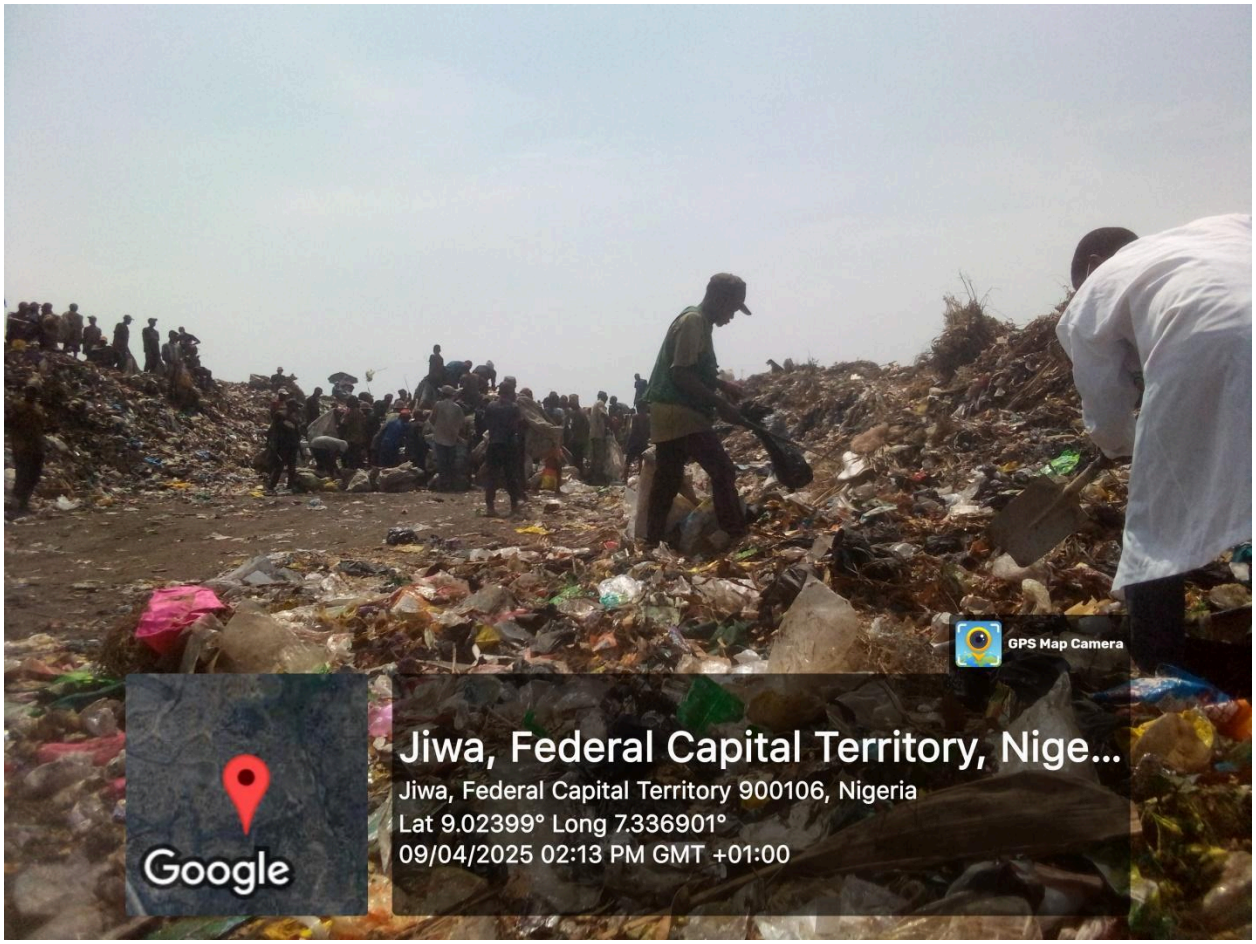


Plate 58: Informal waste pickers at Gosa dumpsite, FCT, Abuja

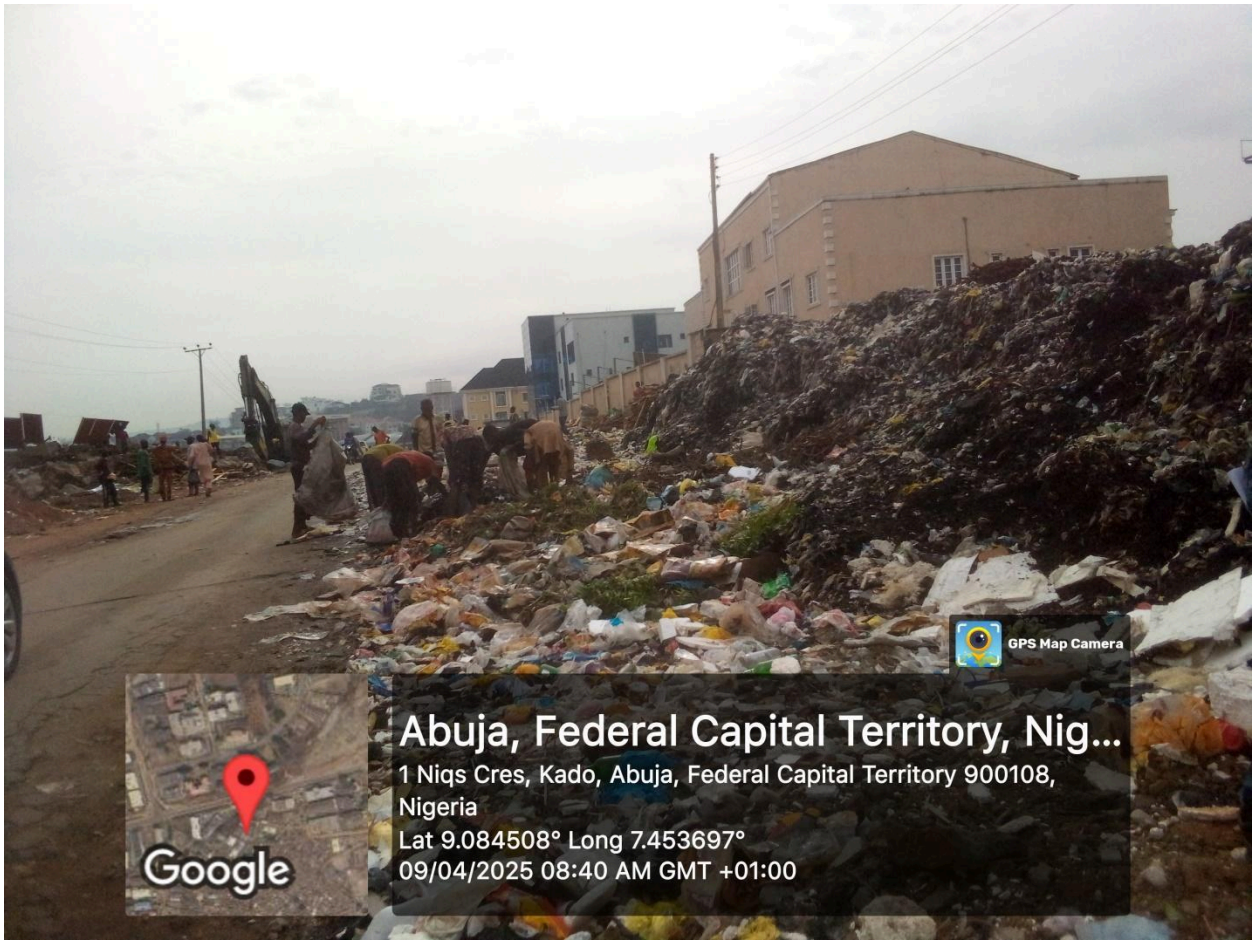


Plate 59: Informal waste pickers at mabushi dumpsite, FCT, Abuja

Ajata and Kubwa Dump Sites: The Ajata dump site began operations in 1999 and no official closure information was available. The Kubwa dump site only operated for about one year after it opened in July, 2004 before problems with odour and random fires forced its closure (AEPB, 2012). The Ajata and Kubwa dump sites sit on a small footprint (approximately 6.5 and 5 hectares respectively) and from field observations, the waste piles observed have been significantly diminished in volume from continuous incineration (Nwosu et al., 2016). Interviews with officials of AEPB indicate that these sites are officially closed with future conversion plans to create allocation stations for waste transfer to Gosa site which is larger and spacious. Notwithstanding, indiscriminate waste dumping was still observed at this dumpsites.

Material Recovery in FCT

Stakeholders in the informal sector in Abuja can be divided into 5 groups. These include household scavengers, street scavengers, mobile waste buyers, scavengers and scrap metal collectors (middlemen). Household waste collectors provide waste collection services using wheelbarrows, carts and tricycles. Sometimes garbage collectors collect household garbage after sorting and sorting. The collected non-recyclable waste is disposed of in unauthorized places, resulting in illegal open dumpsites. As a result, scavengers have been banned from accessing some streets due to their altitude of scattering non-recyclable materials on street. Street collectors also exist in FCT, Abuja known as "mai bola" These collectors pick recyclables from public waste bins before their disposal by AEPB. Street collectors separate and sort recyclables into different components and sell each component to different dealers. Open dump scavengers store secondary raw materials, then sell them in the scrap markets on the edge of the landfill or bring them to the scarcity market or scrap metal dealers (Ogwueleka and Naveen, 2021) (Plates 60 & 61). The income of scavengers depends on the forces of demand and market price. In Goza for example, women, children and Mai Bola participate in the sorting and collection of waste. At the dumpsites, the collectors dismantle the waste heaps or newly disposed waste from trucks, separate the the materials into plastic, metals, bottles, textile and paper. Mobile According to Ogwueleka and Naveen, (2021) Waste Buyers buy recyclable materials such as bottles, glass, plastic items, textiles, used cement bags, used electronic waste and furniture, etc. Mobile scrap metal buyers sell recyclable materials to scrap dealers. Scrap metal dealers are engaged in the conversion and processing of recovered materials into secondary raw materials and sell these materials to recycling companies. Oral interview shows that scrap dealers also deal in multiple components of the waste stream. More so, scrap metal dealers handle the largest volumes of reusable materials as they use trucks or motorized cabs to move their materials, unlike plastic waste pickers.

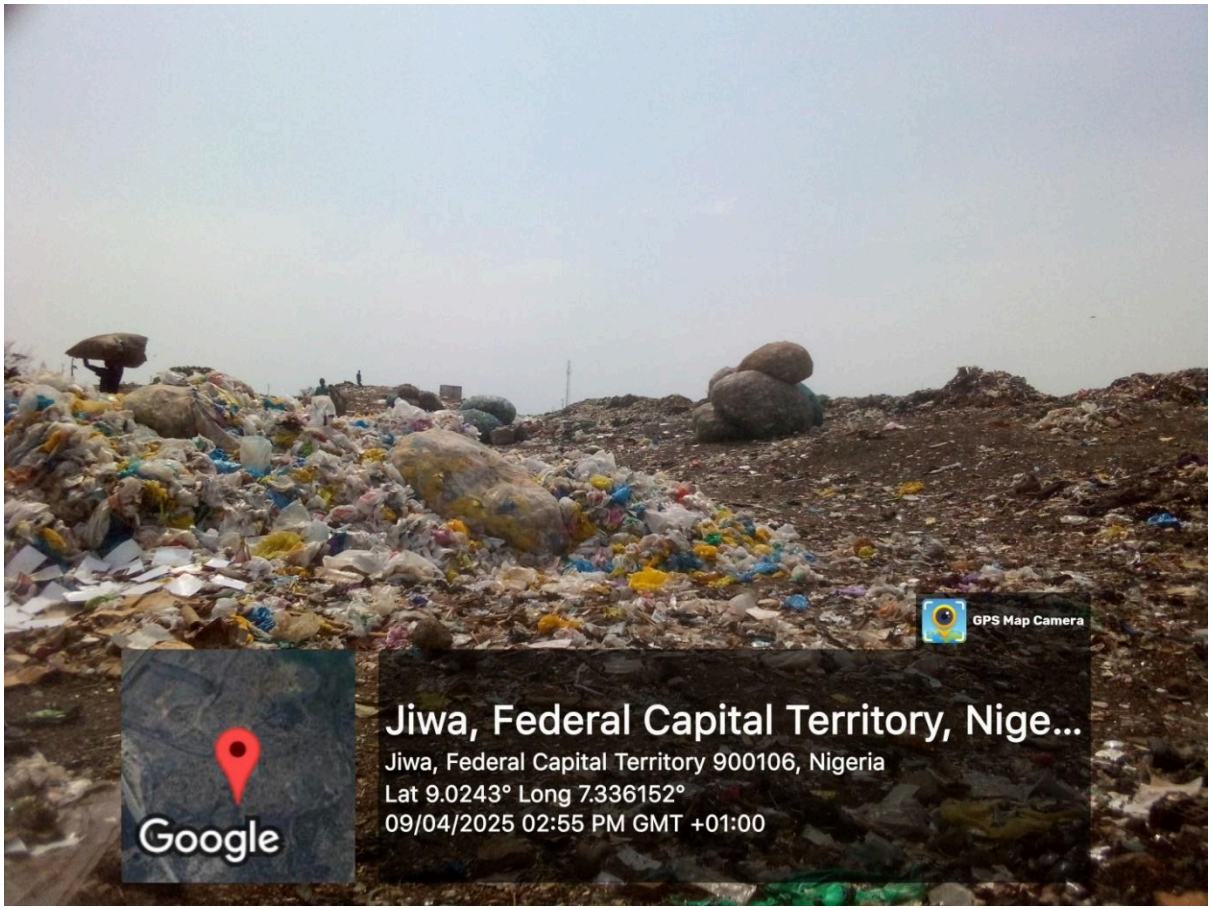


Plate 60: Sorted waste materials are Gosa dumpsite, FCT, Abuja

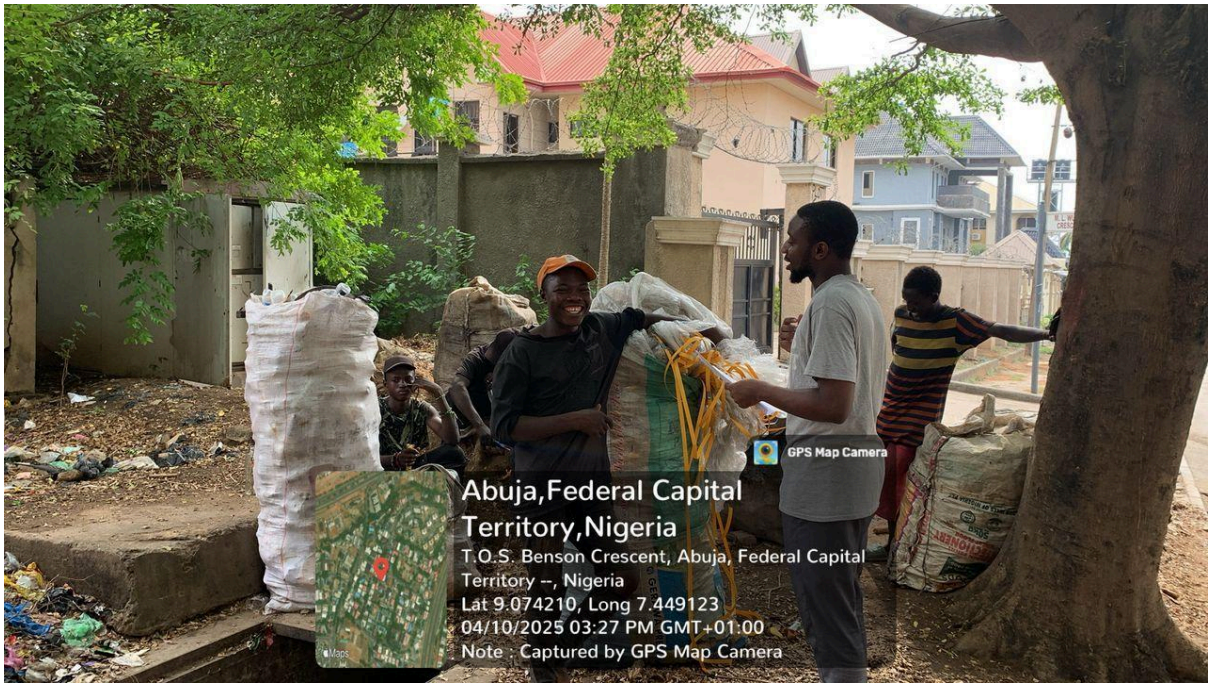


Plate 61: Sorted waste materials by informal waste street pickers, FCT, Abuja

Challenges of MWS Management in FCT

Despite efforts to address waste disposal issues in FCT, including through public-private partnership, heaps of wastes are still been visible across the Federal Capital Territory (Plates 62&63). Our on-the-spot assessment revealed that poor funding of the agency in the form of low budgetary allocation from the government is one of the main reasons for irregular collection and disposal of waste in AMAC, a situation which has rendered the agency incapacitated in handling the increasing solid waste. More so, the existing equipment for solid waste management were grossly inadequate when compared to the population growth of FCT. For example there is gross inadequate coverage of municipal authority's waste collection bins. Some parts of FCT do not have government provided public bins. The negative attitude of households in the disposal of their respective waste to the designated collection points is also a source of concern with respect to MSW management in FCT. For most residents of FCT, as we found in Mabushi area, rather than paying the informal waste collectors to handle their waste opt to dump waste in open spaces and even drainages, generating a myriad of environmental issues. Inadequate manpower and trained staff to handle solid waste management programmes is another challenges issues in FCT. Informal waste pickers also face health and environmental hazards in the cause of their works. Across the FCT, scavengers are exposed to hazardous and un- healthy work environments, mostly carrying out their activities without protective clothing or equipment. The fact that informal sector is unregulated, unrecognized, and often considered illegal is also a source of concern with respect to MSW management. This perception exposes scavengers to exploitation and marginalization by dealers and well as attacks from residents who often consider them as security threats.

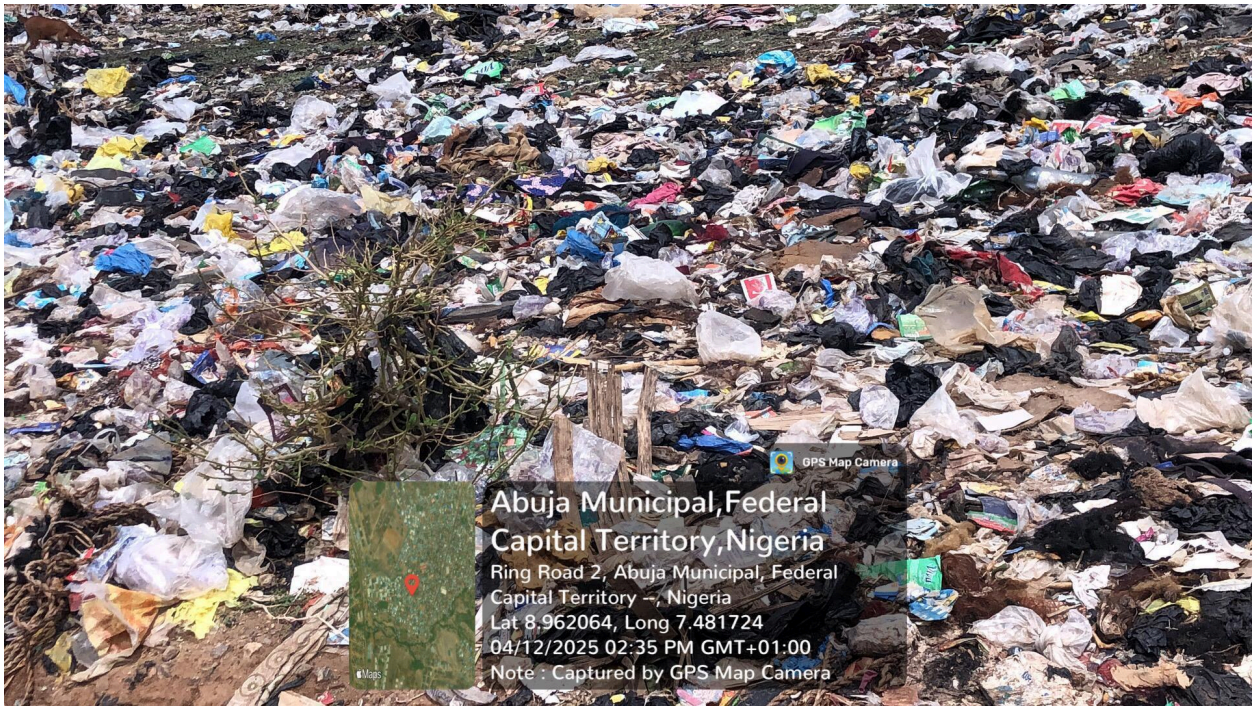
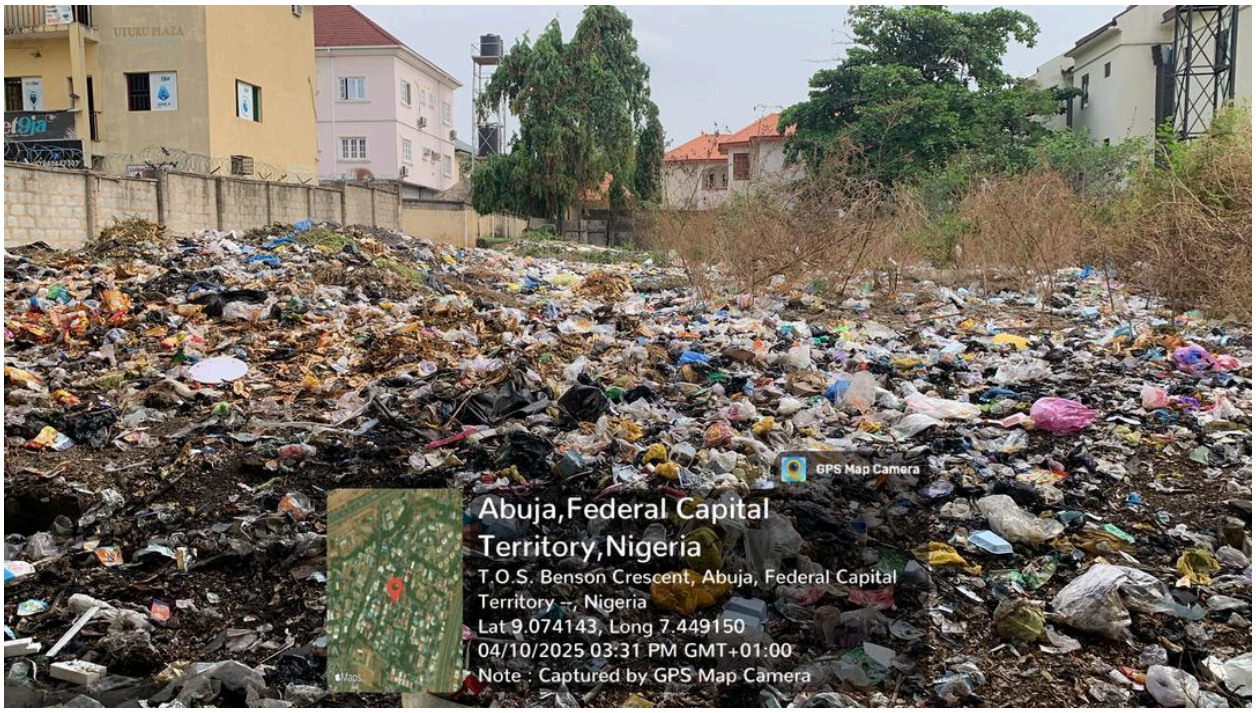


Plate 62: One of the Illegal dumpsite at Ring road 2, FCT, Abuja



. **Plate 63: One of the illegal dumpsite at T.O.S Benson Crescent, FCT, Abuja**

11. FINDINGS FROM ON-THE-SPOT BASELINE SURVEY

11.1. Components of Waste in Benin City, Epe, Lagos State, Jos, Plateau And FCT, Abuja

Across the surveyed States and the FCT, organic waste organic wastes (food/fruits, and garden wastes) dominate the composition of MSW, followed by plastic materials and other (textile, glass/ceramics/metals/aluminium. These biodegradable wastes, originate from households, including peelings from fruit and vegetables, food remnants and leaves. This observation also collaborates with a recent World report in 2025. According to the report high-income countries generate relatively less food and green waste, at 32 percent of total waste, and generate more dry waste that could be recycled, including plastic, paper, cardboard, metal, and glass, which account for 51 percent of waste. Middle- and low-income countries on the other hand generate 53 percent and 57 percent food and green waste, respectively, with the fraction of organic waste increasing as economic development levels decrease (The World Bank Group, 2025). Across the developing countries, the increasing production of fruits and vegetables has resulted in enormous waste and losses. According to a 2019 study by the Food and Agriculture Organization of the United Nations (FAO, 2019), global fruit and vegetable post-harvest losses reached up to 20%, second only to roots, tubers, and oil yielding crops at 25%. Fruit and vegetable post-harvest losses in Sub-Saharan Africa are significant, ranging from 40 to 50% (FAO, 2019). FVW accounts for 44% of total food waste in South Africa, followed by grains (26%), meat (15%), and roots, tubers, and oilseeds (13%) (WWF-SA, 2017). The increasing quantity of organic wastes has been attributed to the fact that fruits and vegetables contain inedible materials that must be discarded (roots, skins, seeds, kernels, peels, shells, leaves etc.). Secondly, unprocessed fruit and vegetables are highly perishable, increasing the likelihood of deterioration before consumption; and iii) because FVWs are less expensive than meat and fish, customers are less concerned about spoilage (Sagar et al., 2018).

In Fig, 2, Benin City recorded an average quantity of organic waste (food/fruits, and garden wastes) as 36.1%, paper (8.5%), plastics (23%), woods (9.85%), while other (textile, glass/ceramics/metals/aluminium) was 22.35%. In Epe town, organic waste was 47.2%, paper (5.9%), plastics (21.5%), woods (5.5%), while other (textile, glass/ceramics/metals/aluminium) was 19.9%. In Jos, Plateau State, organic waste was highest (53.3%). Paper waste was 8.8%, plastics

(21.8%), wood and furniture (7.4%) and others (16.9%). In FCT, organic waste component of MSW was 49.3%. Paper waste was 6.88%, plastic materials was 28.8%, while wood waste and others were 5.67% and 8.9% respectively. (See appendix B for location by location composition). The high quantity of organic waste in Jos may be attributed to the fact that Jos is known for fruits and Vegetables. This assumption is supported by the study of Zitta et al., (2021), who reported that vegetable farming is playing an important role in providing 84% part-time, and 5% full-time employment opportunities as well as reducing food insecurity among the study participants. In addition, most farmers achieved an income of more than the minimum wage of ₦30, 000 (US$ 72. 24) as approved by the Nigerian Government. Plastic material is also an important waste component in Benin, Jos and FCT. These are mostly sachet pure water bags and plastic wraps, technically referred to as Polyethene (PE). Polyethene (PE). Other forms of plastic waste in small quantities in Epe community are High-Density Polyethylene (HDPE), including plastic bottles, milk jugs, shampoo bottles, bleach bottles, and Polypropylene (PP) such as food containers, bottle caps. These types of plastics are few in waste composition due to the activities of waste scavengers and the fact that people reuse them for other purpose such as selling of Hibiscus tea or Roselle drink; known locally as Zobo drink or as containers for selling local herbal drinks.

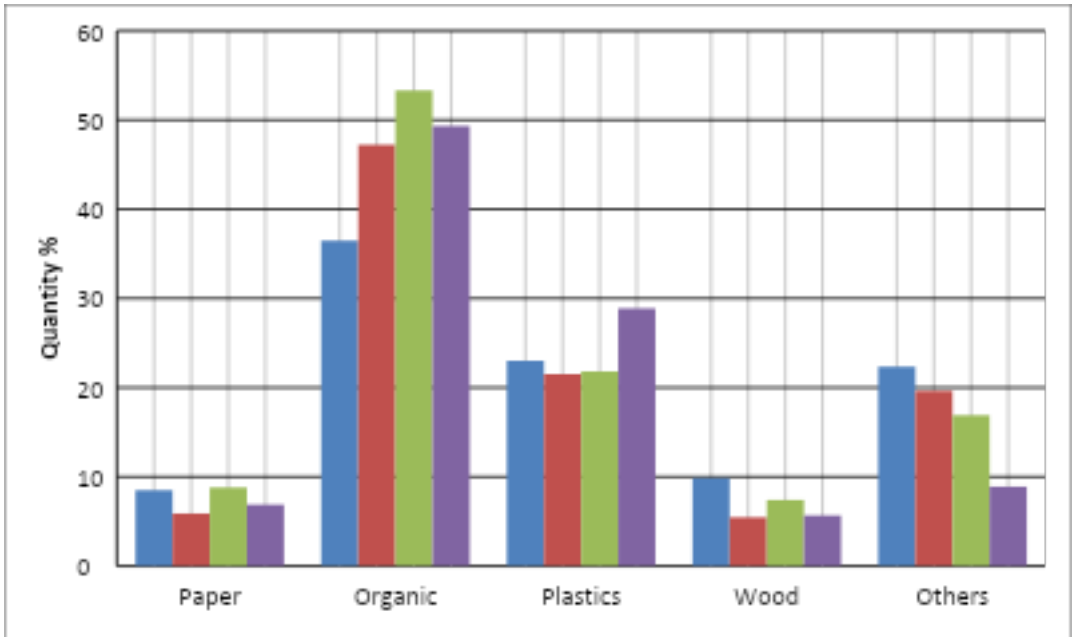


Fig. 2: Mean quantity of waste components across the surveyed States in (%)
Source: Field study (2025)

11.2. Methane Potential Dumpsites in Benin City, Lagos, Jos and FCT, Abuja

Methane potentials of open dumpsites was calculated using the IPCC Zero Order Decay Model (ZODM), a model based on mass conservation technique and degradable organic carbon (DOC) of Municipal Solid Waste (MSW), with the assumption that the amount of methane generated is proportional to the entire amount of waste that has been placed in the landfills. Mean yearly projected total MSW and methane values across the sampled locations are presented in Fig. 3a and b. (See Appendix C for location by location computed methane values) In Fig. 4-7 the spatial distribution of methane for the sampled states are presented.

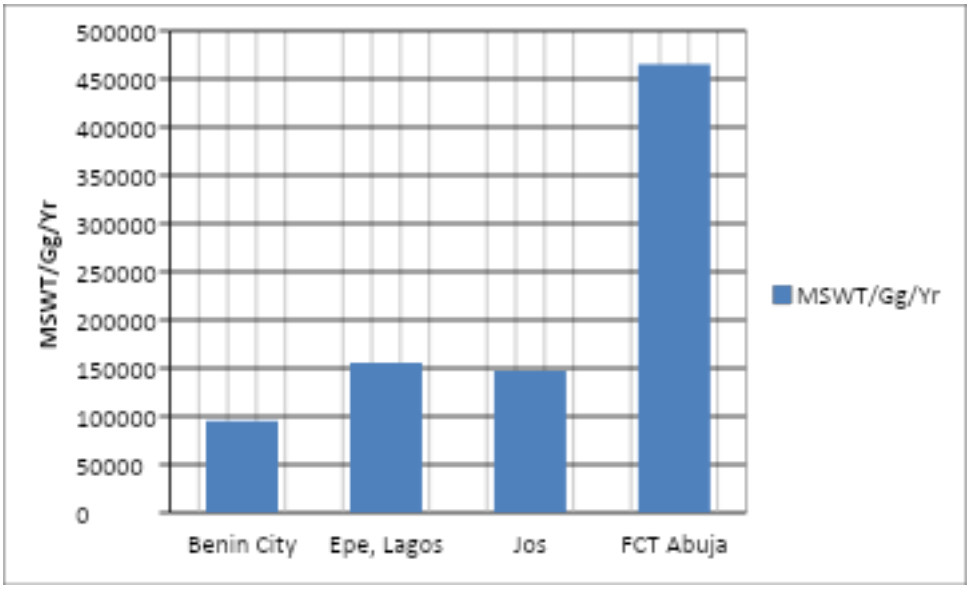


Fig. 3a: Mean projected yearly MSW value across the surveyed States and FCT

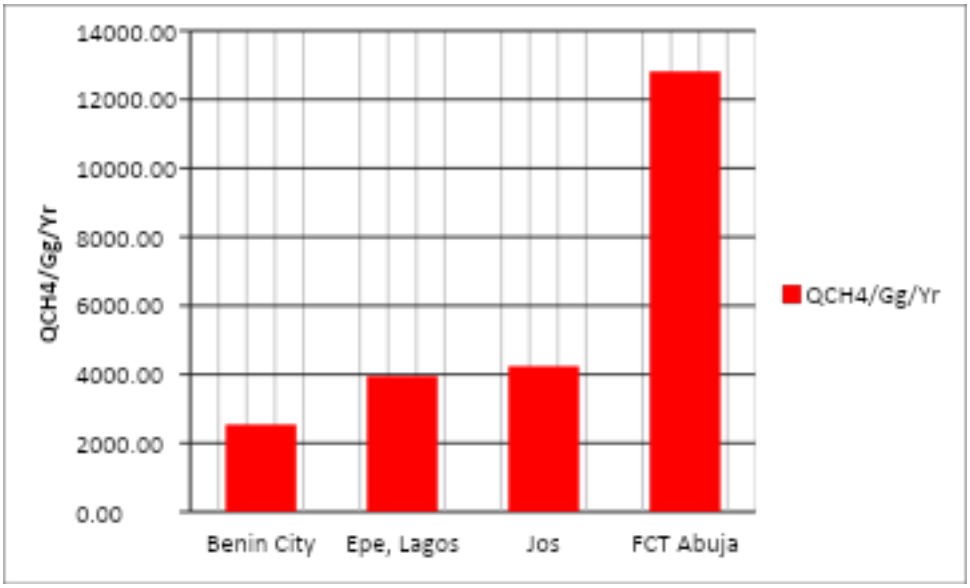


Fig. 3b: Mean Yearly methane value across the surveyed States

11.3. Spatial Distribution of Methane across Nigeria

To produce the spatial maps of methane, methane data were downloaded from Sentinel-5P OFFL CH4 (https://developers.google.com/earth-engine/datasets/catalog/sentinel-5p). The Sentinel-5 Precursor mission instrument collects data useful for assessing air quality. The TROPOMI instrument is a multispectral sensor that records reflectance of wavelengths important for measuring atmospheric concentrations of ozone, methane, formaldehyde, aerosol, carbon monoxide, nitrogen oxide, and sulphur dioxide, as well as cloud characteristics at a spatial resolution of 0.01 arc degrees. The Sentinel-5P OFFL CH_4 specifies a minimum and maximum methane range as 1285ppb (minimum band) and 2405ppb (maximum band). In view of this band, it can be concluded that methane emission levels across the sampled States and the FCT, Abuja are within the band specified by the European Union/ESA/Copernicus dataset (Sentinel-5P OFFL CH_4, 2019)

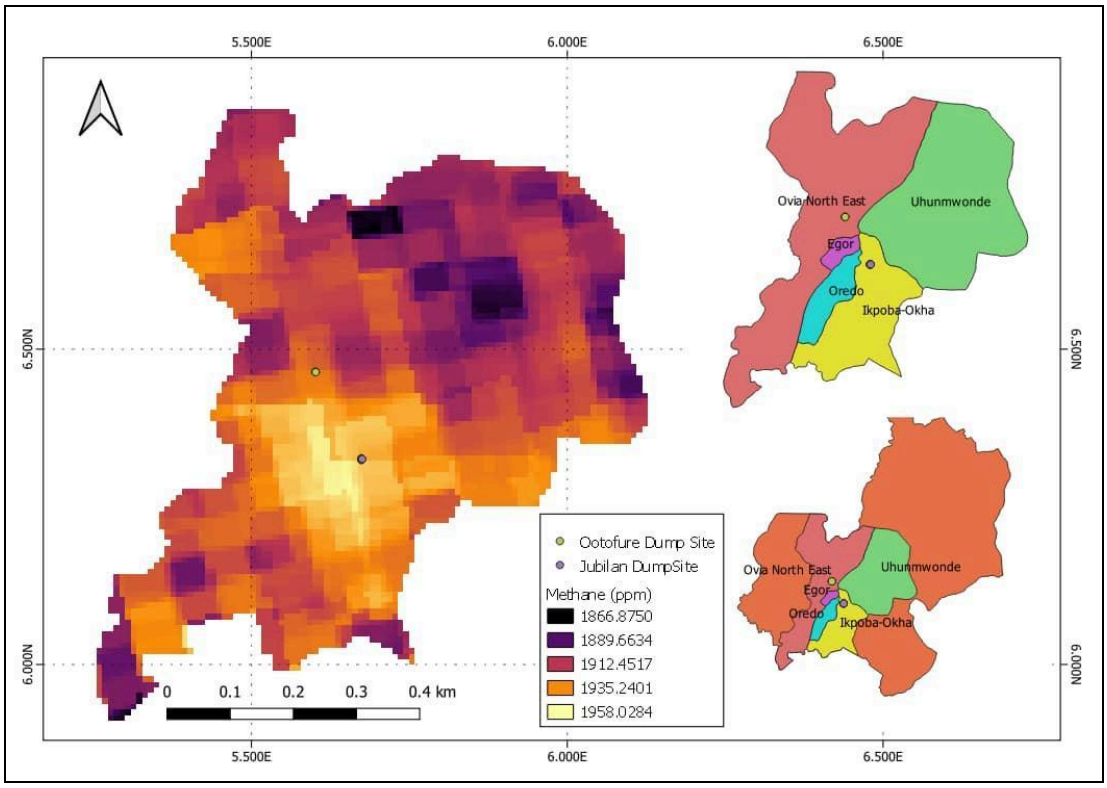


Fig.4 Spatial distribution of methane concentrations across Edo State (ppm): Emphasis on sampled dumpsites

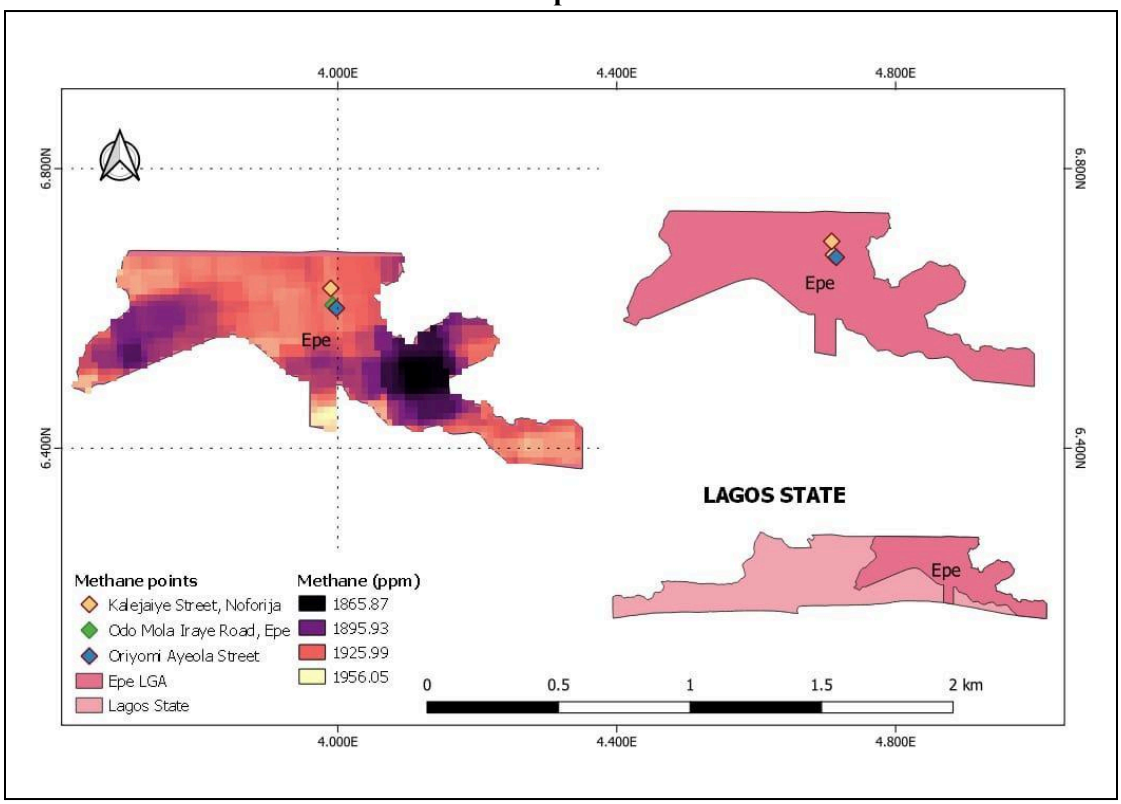


Fig.5 Spatial distribution of methane concentrations across Epe, Lagos State (ppm): Emphasis on sampled dumpsites

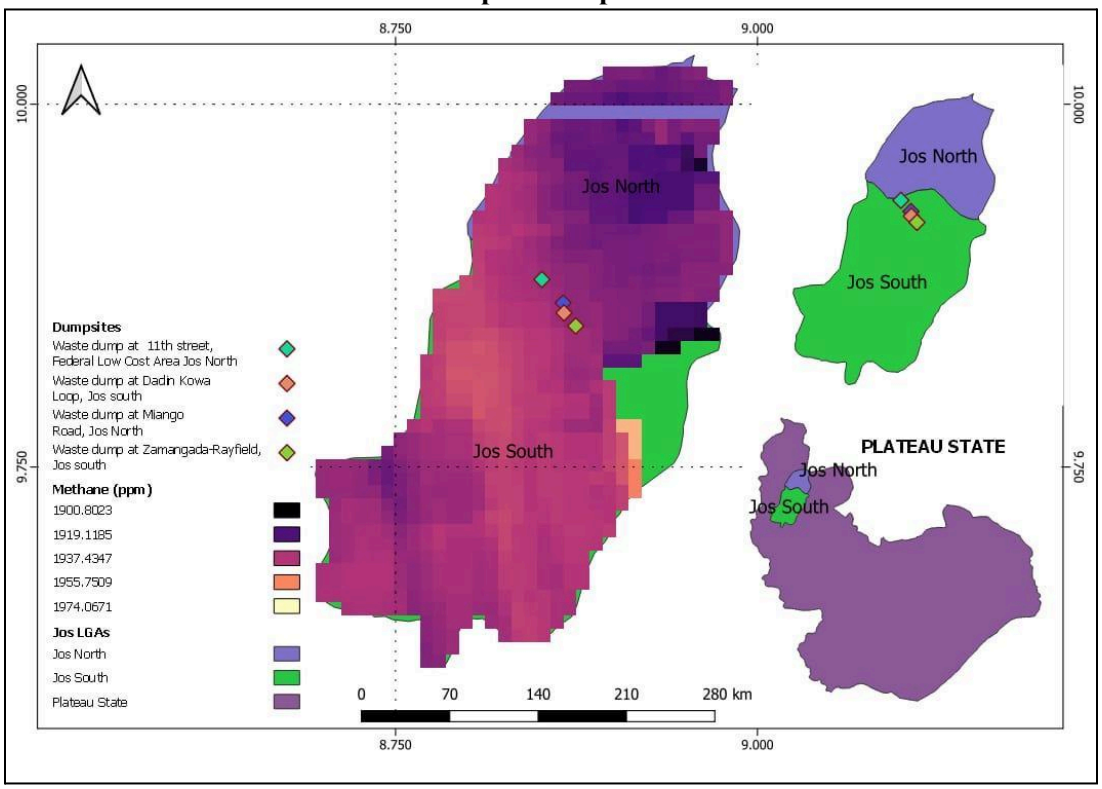


Fig.6 Spatial distribution of methane concentrations across Plateau State (ppm): Emphasis on sampled dumpsites

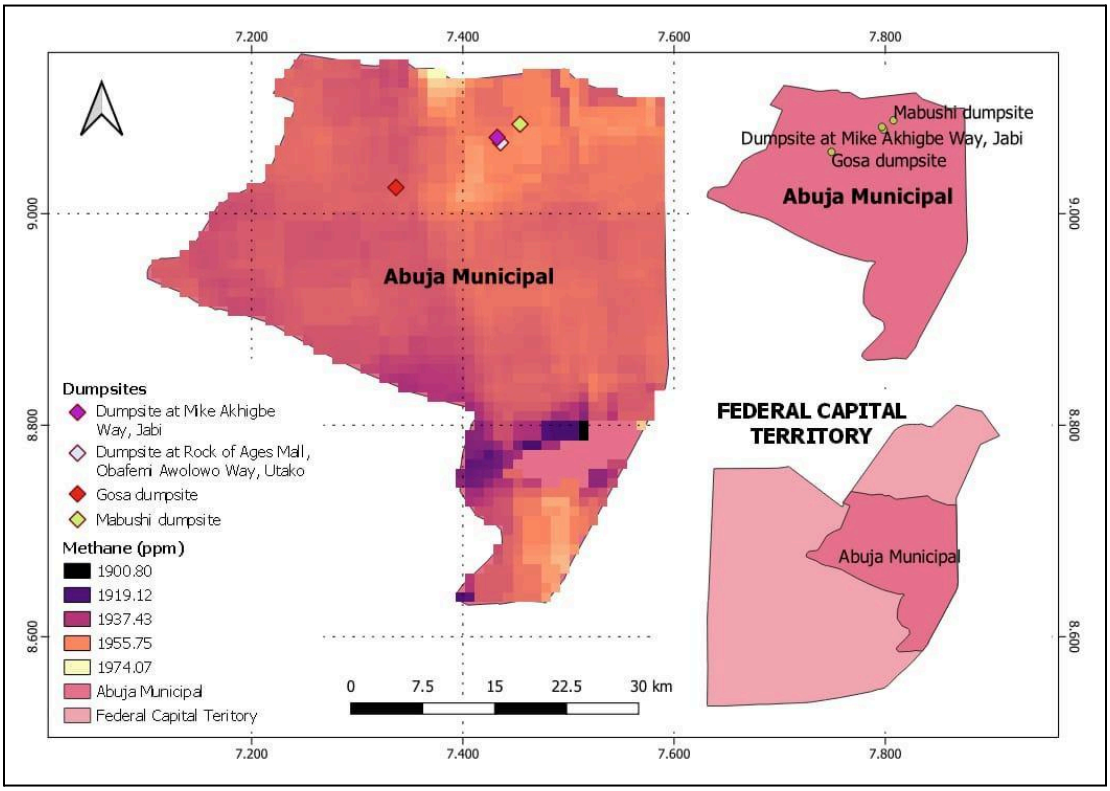


Fig. 7 Spatial distribution of methane concentrations across FCT, Abuja (ppm): Emphasis on sampled dumpsites

11.4. Socio-Demographic Profiles of Sampled Respondents

In Tables 6-9, results of socio-demographic characteristics of sampled respondents are presented. In Benin City and Jos male population dominates farming occupation, while in the FCT and Lagos female are more in farmers operations. Majority of these farmers are within the age bracket of 21-50 years, except for Epe town where most farmers are in their 50years and above. This is followed by the population within the age bracket of 31-40years (24%). This suggests that farming is an important livelihood source for most adults who are also household heads. These age brackets are also productive and whose activities have implications for waste material generation. Generally, of this active age bracket, or active workforce, 80% of sampled farmers are married with families, while the remaining are either single or never married. Majority of the farmers interviewed are school certificate holders. This has implications with regards to reading manuals and other information regarding organic fertilizer use and handling. Since farmers are major players in organic waste generation, training is required to increase awareness as well as farmer's involvement in the material recovery process. Average monthly income of farmers in ranges from ₦100,000 to ₦ 200,000. However for most farmers monthly income level is less than ₦ 100,000. These further buttress the fact that faming is an important livelihood source in the studied communities, even though these farming operations are done at subsistence levels. By being part of the material recovery chain, farmers will witness income increase through the Waste-Cash component of the material recovery value chain. About 40-50% of sampled farmers have between 6 years to 9 years farming experience. As for material recovery, old famers may have higher tendency to practice sustainable waste management due to the size of their farms, and their capacity to generate more materials for composting. Table 6 also shows that about 52% of sampled farmers are already subscribing to the use of manure to augment chemical fertilizer.

Socio-Demographic Profiles of Farmers and their Potential Participation in Material Recovery Process

Table 6: Socio-demographic Characteristics of sampled farmers

			Percentage	
Variables	**Benin City**	**Jos**	**FCT**	**Lagos**
Gender				

Male	76	60	48	48
Female	24	40	52	52
Age group				
<20 years	0	8	4	4
21-30years	28	28	32	8
31-40years	36	20	20	24
41-50years	28	24	16	16
>50years	8	20	28	48
Marital status				
Married	68	84	56	92
Never married	32	16	36	8
Divorced	0	0	4	-
Other (co-habiting)	0	0	4	-
Highest educational qualification				
School Cert.	68	64	64	76
B.Sc./HND	16	36	32	20
Masters	8	-	4	4
Ph.D	4	-	-	-
No formal education	4	-	-	-
Monthly income level				
< 100,000	72	28	56	36
100,001 - 200,000	28	52	36	40
200,001 - 300,000	0	20	12	12
> 300,000	0	0	16	12
Years of farming?				
< 3 years	20	12	32	20
4 - 6 years	24	28	20	12
7 - 9 years	4	8	0	28
> 9 years	52	52	48	40
Use compost manure on your farm				
Yes	52	88	56	52
No	48	12	44	48

Source: Field work (2025)

Socio-Demographic Profiles of Households and Their Potentials Participation in Material Recovery Process

In Tables 7, results of socio-demographic characteristics of sampled households are presented. Majority of interviewed household heads are mostly females (72%), compared to the male household heads. The increasing female household headship maybe attributed to the fact that most of the males leave home for work while their wives stay back to take care of the house chores. Hence, as at the time of this survey, the researchers encountered more females than males. For Epe, though most families reside in Epe town, most of the married men work in Lagos major towns, and this arrangement is necessitated by the need to minimize cost of living

with their entire families in the city of Lagos. The majority of sampled households are within the age bracket of 31 years and 50years. These age brackets have implications for material generation and disposal practice. Young people have an increased tendency to generate more waste due to their lifestyle as well as can be effective in recovery/recycling activities. The proposed Material Recovery Facility also requires labour/workforce which the young population can provide and earn a living through waste to cash initiative. About 70-85% of sampled households are married. Similar to the pattern observed among farmers, majority of the household heads interviewed are school certificate holders (84%), with only 20.0% having B.Sc./HND. In order to sustain household participation in Multi solving action for Methane Reduction in Nigeria (Material recovery process), there is need for more sensitization training and workshops. Education is a major determinant in waste disposal practice. Educated population will perceive sustainable waste management as very important considering its environmental impacts; hence their willingness to pay for waste collection and also participate in the material recovery process will be high compared to the less educated population. Majority of sampled households live on a monthly income of less than ₦100, 000. This buttresses the poverty level in many communities in Nigeria and why mostly young men example in Epe town have migrate to Lagos in search of better living standard, only to return on weekends. The percentage of families that combine Public Service/Private Business especially farming is also an indication of community struggles to make a meaningful livelihood. The Proposed Material Recovery facility holds potential to create jobs and more so, the expected wide practice of composting and training of community population will empower young people to further create employment opportunities. About 84% of sampled residents do not practice source segregation, and this has implications for sustainable waste management. The material recovery initiative is aimed at achieving zero waste, especially through minimizing the volume of organic and recyclable materials going into dumpsites, both of which contribute to GHGs such as methane through decaying process and CO_2 during burning at open dumpsites. To achieve this Zero Waste initiative, intensive and expensive sensitization and training programme must be incorporated in the Material recovery model. Even for a very few population that intentionally practiced sorting, only 16% - 38% carry out full sorting. It is important to note that at the current, waste collection by authorities has no provision for sorted materials. The remaining 57% - 80% of sampled household also practice partial sorting. In this practice, bottles, metals and plastics are put together for sale to waste pickers. On whether community practice compositing at home, about 40% - 80% of sampled household do not practice composting. This percentage also simply throws their organic waste into government provided bins. Another 8% - 32% agreed that they use their organic waste as manure in their garden without composting in a pile or trench.

Table 7: Socio-demographic Characteristics of sampled Households

	Frequency			
Variables	**Benin City**	**Jos**	**FCT**	**Lagos**
Gender				
Male	44	44	48	28
Female	56	56	52	72
Age group				
<20 years	12	8	0	0
21-30years	16	32	32	12

31-40years	40	36	44	36
41-50years	12	16	16	28
>50years	20	8	8	24
Marital status				
Married	56	60	64	80
Never married	44	32	28	0
Divorced	0	4	4	8
Other (co-habiting)	0	4	4	12
Highest educational qualification				
School Cert.	77	48	68	84
B.Sc./HND	12	52	32	16
Masters	7	-	-	-
Ph.D	4	-	-	-
No formal education	4	-	-	-
Monthly Income Level				
< 100,000	48	48	20	64
100,001 - 200,000	36	36	28	28
200,001 - 300,000	12	12	20	8
> 300,000	4	4	32	0
Occupation?				
Government Public Service	4	20	20	20
Private Institution	24	32	40	32
Public Service/Private Business	68	40	40	44
Farming	4	8	0	4
Length of stay in this neighbourhood				
< 3 years	16	24	12	12
4 - 6 years	12	32	28	24
7 - 9 years	20	8	12	12
> 9 years	52	36	48	52
Practice of source sorting				
Yes	38	28	25	16
No	62	72	75	84
Types of sorting?				
Partial sorting	57	100	71.4	75
Complete sorting	42.7	0	28.57	25
Practicing composting at home				
Always (As manure)	16	8	32	32
Sometimes	0	36	32	28
Never	84	56	36	40

Source: Field work (2025)

Socio-demographic Profiles of Market Women/Men (Fruit/Vegetable Sellers) and Their Potentials Participation in Material Recovery Process

In Tables 8, results of socio-demographic characteristics of sampled Market Women/Men (Fruit/Vegetable Sellers) and their Potentials Participation in Material Recovery Process is presented. Most of the fruit and vegetable sellers are females, compared to the male population. The fact that women dominate fruit selling might be attributed to multiple factors, including cultural norms, economic realities, and historical traditions, where women are often seen as having a greater role in community trade. This also points to gender issues and disparity regarding women's economic participation in formal sectors. Across Africa Women feature significantly in trade including buying and selling of goods, across borders trades, produce products, especially food, fruit and vegetables. This is even more so in rural communities where women work outside the home and greatly support household financial decisions. Most of the respondents sampled have attained the age of 30years - 50 years above, and are also married (44% -79.2%). People's age has implications for waste generation. With respect to age, Talalaj and Walery (2015) found that the age structure of a population affects waste generation. The age group 20-29 years seems to contribute the least in terms of solid waste generation (Struk and Soukopová, 2016). Their study also stressed that the age group 40-49 years have an extended budget due to long years of job experience and significantly affects their waste generation. People in the age bracket 50-79 years contribute the most to the overall municipal solid waste generation with the highest values observed among ages 65-69 (Talalaj and Walery, 2015; Struk and Soukopová, 2016). This suggests people are likely to generate different amounts of waste over their lifetime. In another study, Olayungbo and Fadare (2014) argued that age is insignificant to influence waste generation in selected wards of Ife central local governance area in Nigeria

About 90% of sampled respondents are school certificate holders, while on the average, sampled fruits/vegetables sellers make less than 100,000 every month. This also demonstrates the level of poverty and relationship between illiteracy and poverty level in Nigeria. Fruits/vegetable sellers are a success indicator of the proposed Multi solving action for Methane Reduction in Nigeria (Material recovery process). To successfully engage their participation more sensitization

training and workshops are necessary to raise their awareness of the implications of improper waste handling and the waste-cash benefits of the proposed material recovery initiative. More so, most of the market women sampled have been in the fruits and vegetables business for an upward of 6years -9 years, hence their experiences will contribute in no small way to the material recovery value chain as they understand and know where to source compostable materials

Table 8: Socio-demographic Characteristics of sampled fruits/vegetable sellers

	Percentage			
Variables	**Benin city**	**Jos**	**FCT**	**Lagos**
Gender				
Male	48	44	48	4
Female	52	56	52	96
Age group				
<20 years	12	8	0	0
21-30years	32	32	32	4.2
31-40years	24	44	44	4.2
41-50years	24	16	16	20.8
>50years	8	8	8	70.8
Marital status				
Married	48	44	52	79.2
Never married	52	56	40	0
Divorced	0	0	0	8.3
Other (co-habiting)	0	0	8	12.5
Highest educational qualification				
School Cert.	80	96	56	92
B.Sc./HND	20	4	40	8
Masters	-		4	-
Ph.D	-	-	-	-
Monthly income level				
< 100,000	48	48	48	58.3
100,001 - 200,000	32	40	36	33.3
200,001 - 300,000	12	8	8	8.2
> 300,000	8	4	8	0
No. of Years in fruit business				
< 3 years	16	20	28	16.7
4 - 6 years	52	48	20	16.7
7 - 9 years	24	8	28	20.8
> 9 years	8	24	24	45.8

No. of years in this market				
< 3 years	52	24	28	20.8
4 - 6 years	32	36	32	16.7
7 - 9 years	12	12	16	16.7
> 9 years	4	28	24	45.8

Source: Field work (2025)

Socio-Demographic Profiles of Waste Pickers and their Potentials Participation in Material Recovery Process

In Tables 9, results of socio-demographic characteristics of sampled Waste Pickers and their Potentials Participation in Material Recovery Process are presented. It can be seen that waste picking is male dominated operation (82%-93.75%), and these are young adults in their 20years-40yaesr, but most especially between 20-30years. In Benin City, Jos town and Epe there are very few cases of women involvement in waste picking as can be seen from Table 35. Waste picking is labour intensive and will affect young males. Most times, waste pickers have to walk many miles daily to pick up waste under the hot sun or in heavy rain. More so they carry heavy loads on their backs or push carts to transport their collected waste. In addition, majoring to sampled waste pickers either did not attain any form of education (44% -96%) or are just holders of school certificate (4% - 33%). This was expected as the majority of sampled waste pickers migrated from northern parts of the country and other neighbouring countries where high poverty rates, insecurity, cultural factors, and limited access to quality education have resulted in a large number of out-of-school children, particularly girls. Again, most of the sampled waste pickers have lived in their respective communities for more than 5 years on the average, and have also been involved in waste picking for over 3 years – 6 years, hence their understanding of the environment and flashpoints for material collection will be key in the proposed material recovery initiative. In Table 35, majority of sampled informal waste pickers are already members of one corporative/ Union or the other. This makes it very easy for integration into the proposed MRF initiatives. More so these informal waste pickers indicated willingness to join any formal waste management system if such system does exist.

Table 9: Socio-demographic Characteristics of sampled Waste Pickers

	Percentage			
	Benin city	**Jos**	**FCT**	**Lagos**
Variables				
Gender				

Male	82	84	100	93.8
Female	18	16	0	6.3
Age group				
<20 years	20	40	16	0
21-30years	64	36	68	50
31-40years	4	8	16	31.3
41-50years	8	8	0	12.5
>50years	4	8	0	6.3
Marital status				
Married	20	28	8	31.3
Never married	76	64	92	6.3
Divorced	0	0	0	18.8
Other (co-habiting)	4	8	0	43.8
Highest educational qualification				
No education.	96	68	60	44
B.Sc./HND	-	4	-	6
Masters	-	-	-	-
School Cert	4	22	29	33
No. of Years as a waste picker				
< 3 years	68	56	68	12.5
4 - 6 years	24	28	28	31.3
7 - 9 years	4	8	0	43.8
> 9 years	4	8	4	12.5
No. of years in the community				
< 3 years	68	60	76	18.8
4 - 6 years	24	20	24	43.8
7 - 9 years	4	8	0	31.3
> 9 years	4	12	0	6.3
Member of a cooperative?				
Yes	64	12	100	50
No	36	88	0	50
Willingness to join a formal system, if such exists?				
Yes	88	52	96	37.5
No	0	8	0	25
Maybe	12	40	4	37.5

Source: Field work (2025)

Local Government Initiative on Waste Management and Potential Roles in MAMRN

Policies play a crucial role in sustainable waste management through establishing frameworks, regulations, and incentives to promote responsible waste handling, recycling, and resource conservation and recovery, hence minimizing environmental pollution, health risks and fostering

a circular economy. In implementing Multi-Solving Action for Methane Reduction project, the government and municipal authorities will among other things, set the stage for sustainable structures, through establishing regulatory frameworks, and enacting policies that provide the legal foundation for waste management, from collection and sorting to treatment and disposal. However, to effectively embark on this framework is required on the success stories and challenges of existing waste management structures, as well as identification of areas of improvement. In Figs 7- 30, the perception of waste management officials on waste handling and areas of improvement are presented. For all the States and the FCT, respondents indicated that waste collection is structured to be regular (44%-68%), cases of irregular collection were also reported (16%-28%), and this was attributed to poor funding (fuels, repairs of damaged equipment), breakdown in collection trucks etc. There were also cases of some locations having not formal collection system while in Jos town and FCT community managed collection is a common practice (Figs 8-11). In Figs 12-15, officials of waste management authorities expressed varying opinion on the way forward towards effective solid waste management in the respective states. In Benin City and the FCT, respondents indicated that better enforcement of existing waste management laws are key success indicators. In Epe town Lagos and Jos Town, more funding of waste management agency is top on the list of factors to improve waste management. Another key factor of sustainable municipal solid waste management success is greater community participation in waste management initiatives.

In Fig 16-19, there are divergent views on the enforcement of waste handling penalties in across the sampled states and the FCT, Abuja. Responses from MSW managers in Benin City and Lagos confirmed the existence of strict penalties for indiscriminate waste handling (36% -76%), while in Jos town and the FCT, Abuja respondents indicated that though these laws exist, enforcement of the penalties remain a huge challenge. More so, very few of the respondents also indicated that laws that enforce penalties on indiscriminate waste disposal does not exist in there localities as no offender or group of person (Offenders) has/have ever been penalised for indiscriminate waste disposal. On MSW staff's Level of knowledge of on-going composting initiative to encourage farmers, there is general high level of awareness that governments and municipal authorities have plans (other than MRF) to promote bio-fertiliser initiatives in their respective states (through a public-private partnership initiatives), though these plans are still on-going and not concrete, as can be seen in Benin City, FCT, Abuja and Jos. However for other

respondents, no such plans exist or there to not know about such plan for composting initiatives in their states (Figs. 19-22). In Figs. 23-26, majority of the waste management officials indicated that conducting awareness campaigns is the most sustainable way sustain composting initiative (52%-76%), while other respondents argued that providing financial incentives especially through free training on composting and take grants will guarantee composting success. Finally, in Figs 27-30, most of the sampled waste management officials indicated that the best ways government can promote source segregation are through training/provision of incentives for informal waste pickers (32% 44%), provision of better waste collection and sorting infrastructure (20%-44%), effective polices/enforcement of separation laws (4%-24%) and community awareness campaign/engagement (8%-20%).

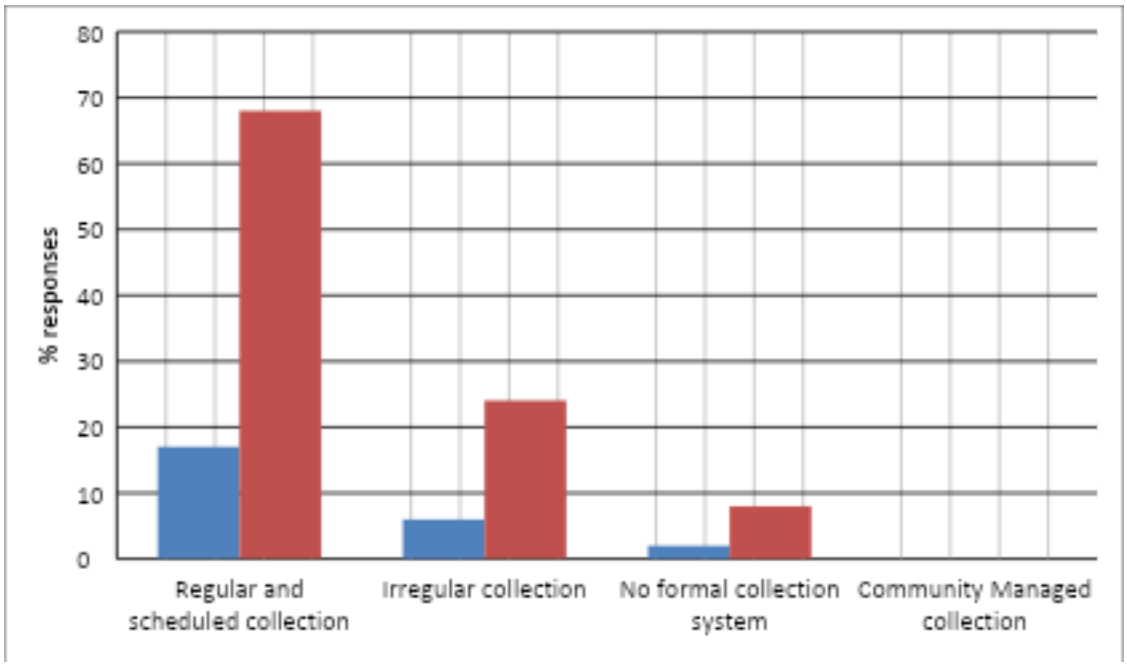


Fig. 8: MSWM Official Response to Waste management in Benin City, Edo State

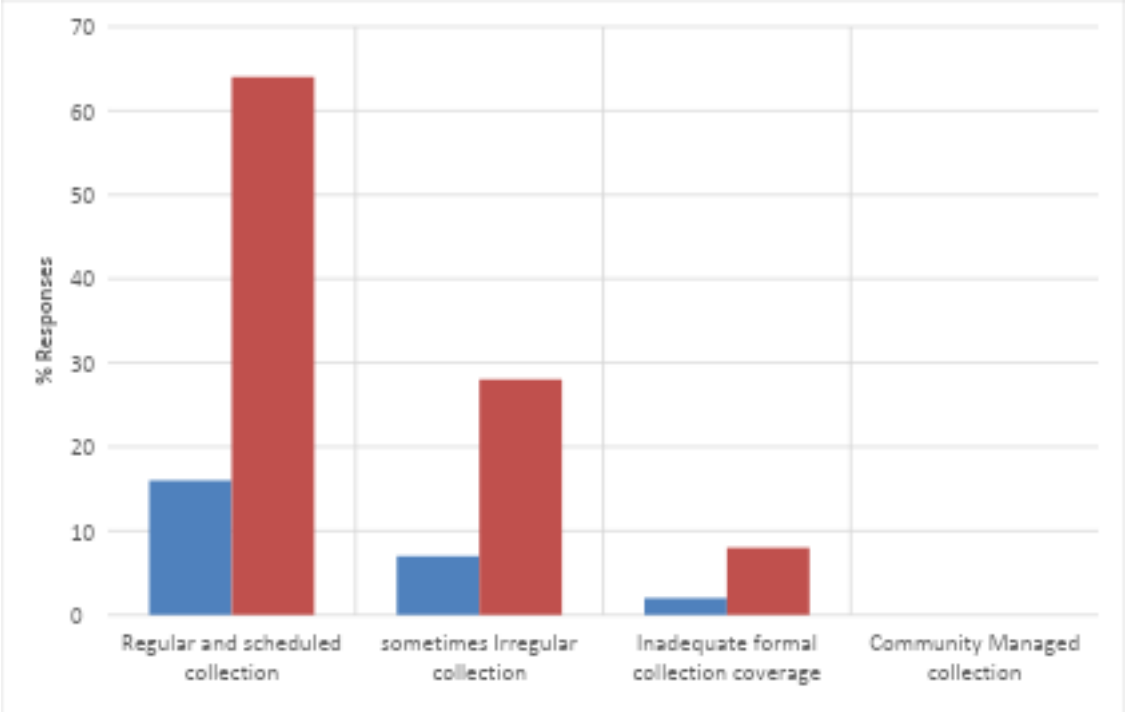


Fig. 9:MSWM official Response to Waste management in Epe community, Lagos

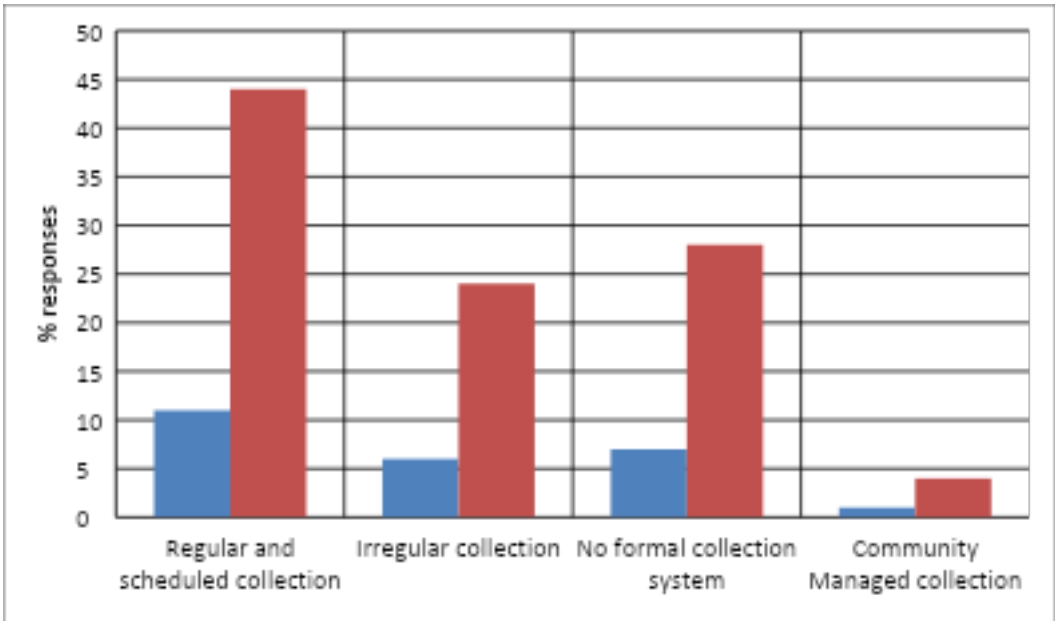


Fig. 10: MSWM official Response to Waste management in Jos, Plateau State

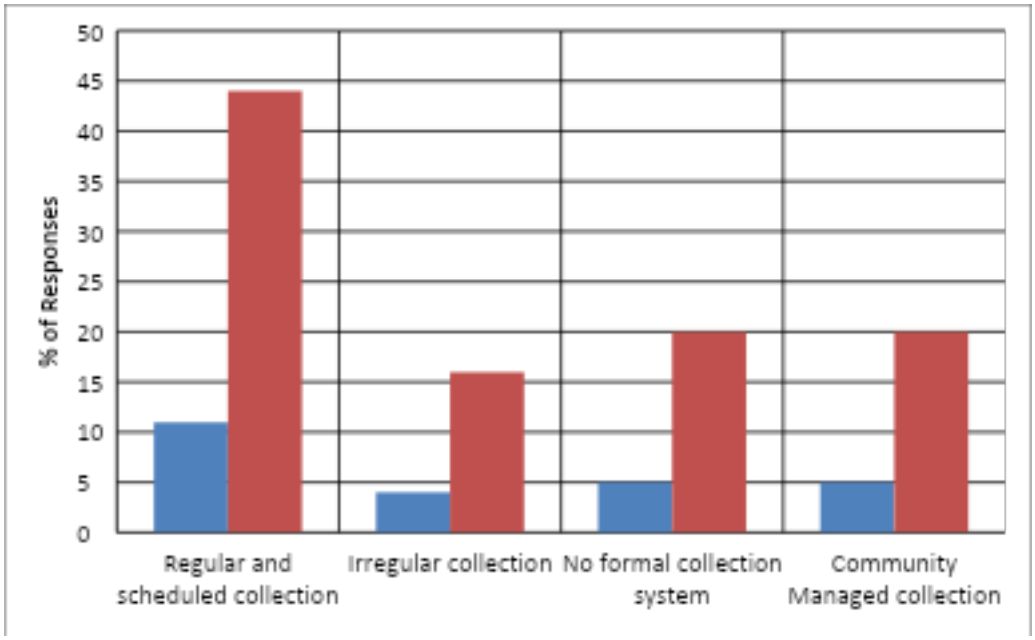


Fig. 11: MSWM official Response to Waste management in FCT, Abuja

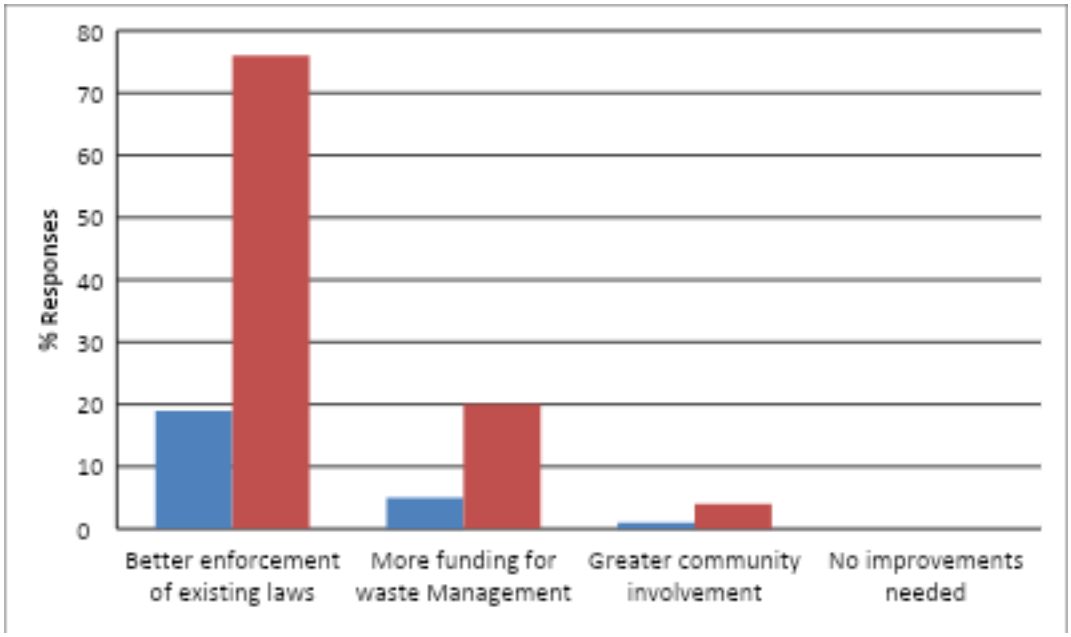


Fig. 12: Perceived areas of Waste management improvement in Benin City, Edo State: Responses from MSW managers

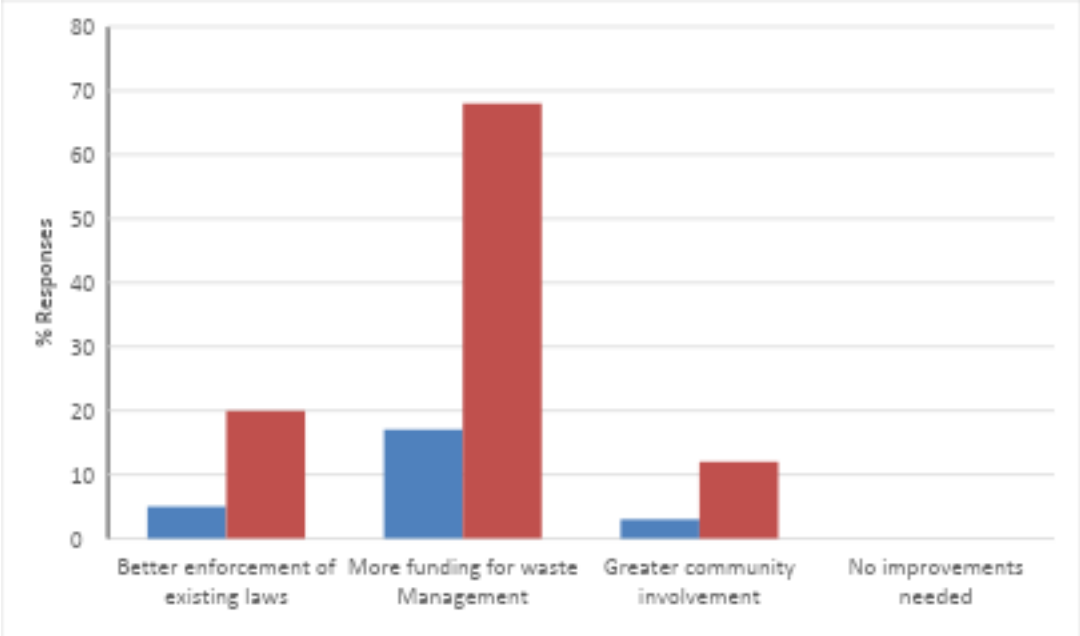


Fig. 13: Perceived areas of Waste management improvement in Epe community, Lagos State: Responses from MSW managers

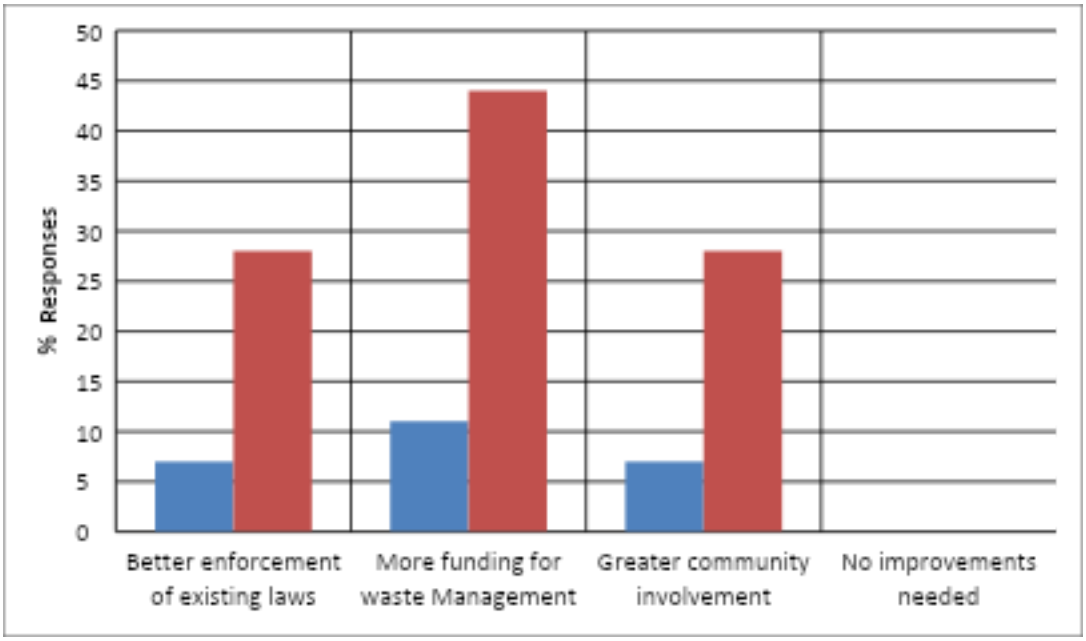


Fig. 14: Perceived areas of Waste management improvement in Jos, Plateau State: Responses from MSW managers

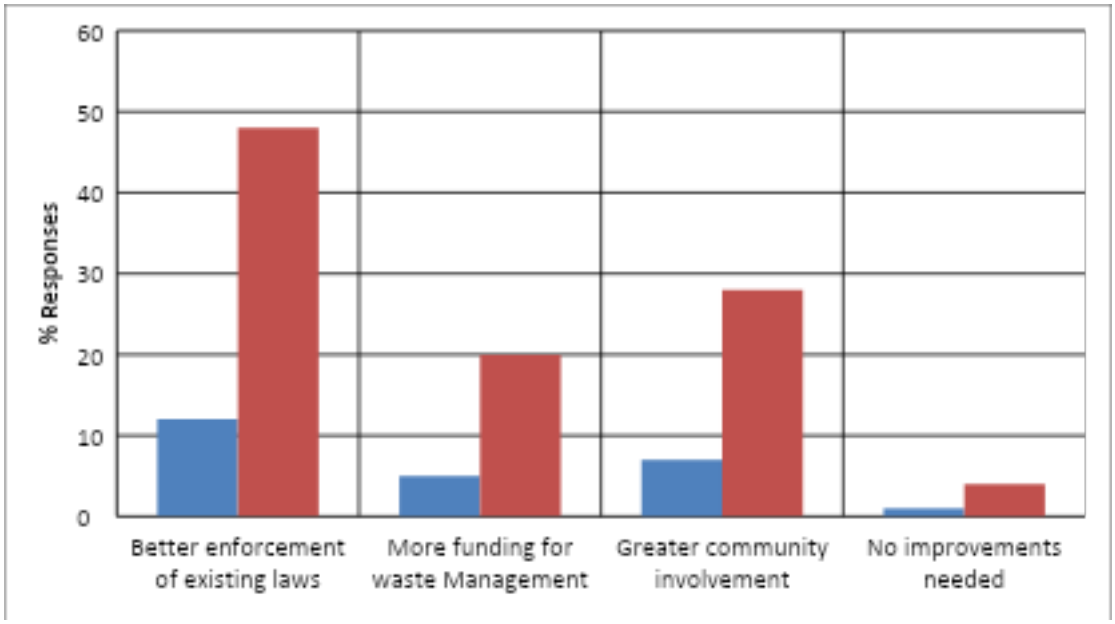


Fig. 15: Perceived areas of Waste management improvement in the FCT, Abuja: Responses from MSW managers

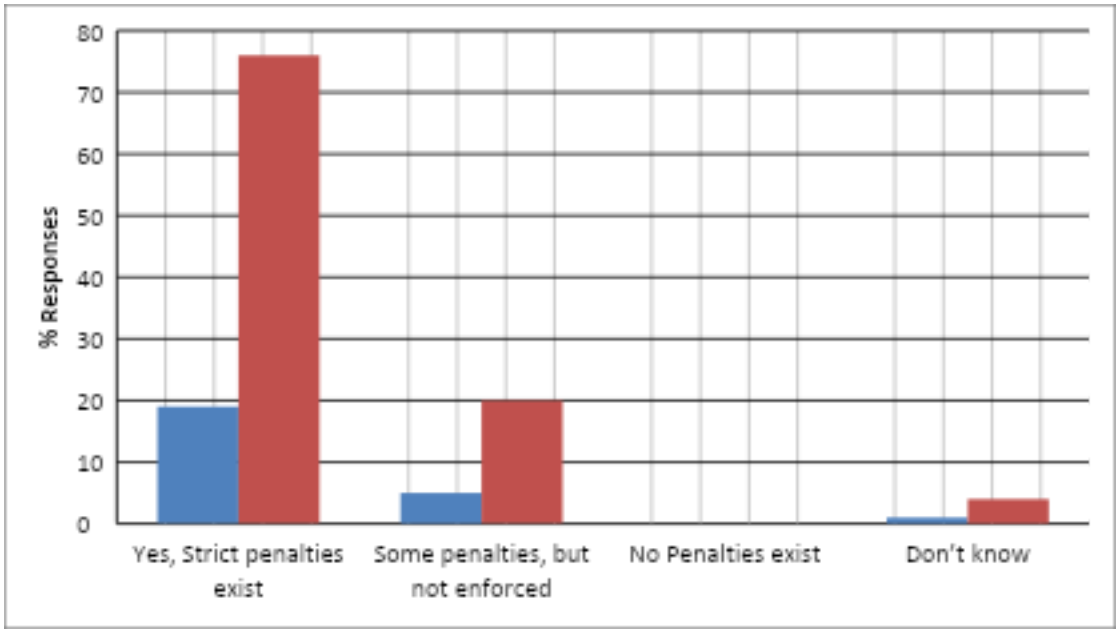


Fig. 16: Enforcement of waste handling penalties in Benin City, Edo State: Responses from MSW managers

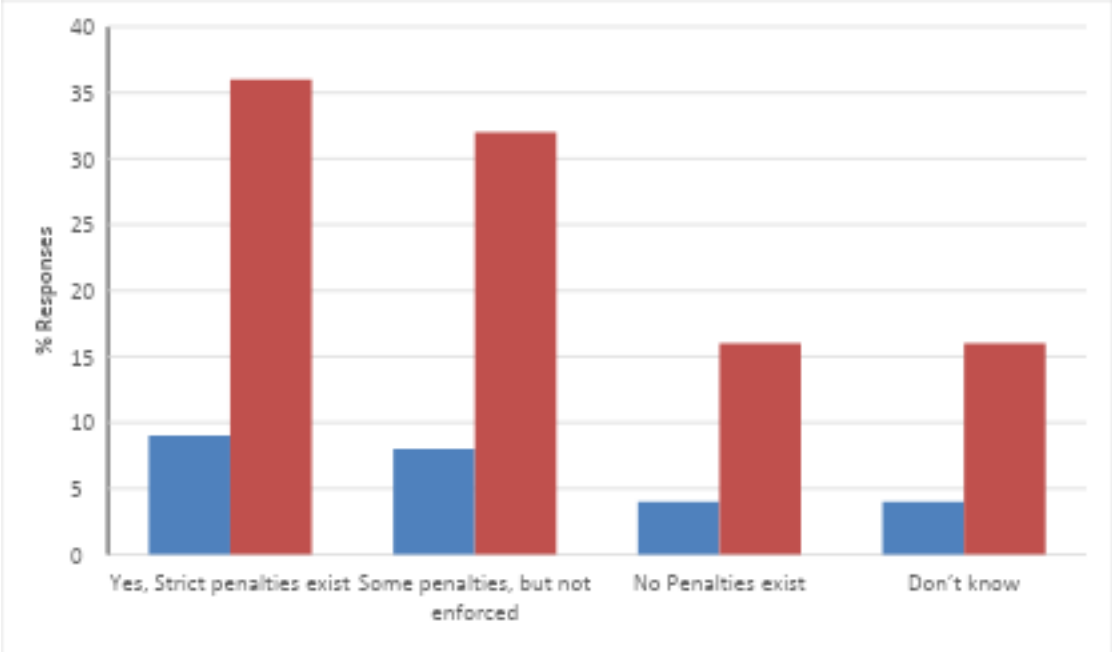


Fig. 17: Enforcement of waste handling penalties in Epe, Lagos State: Responses from MSW managers

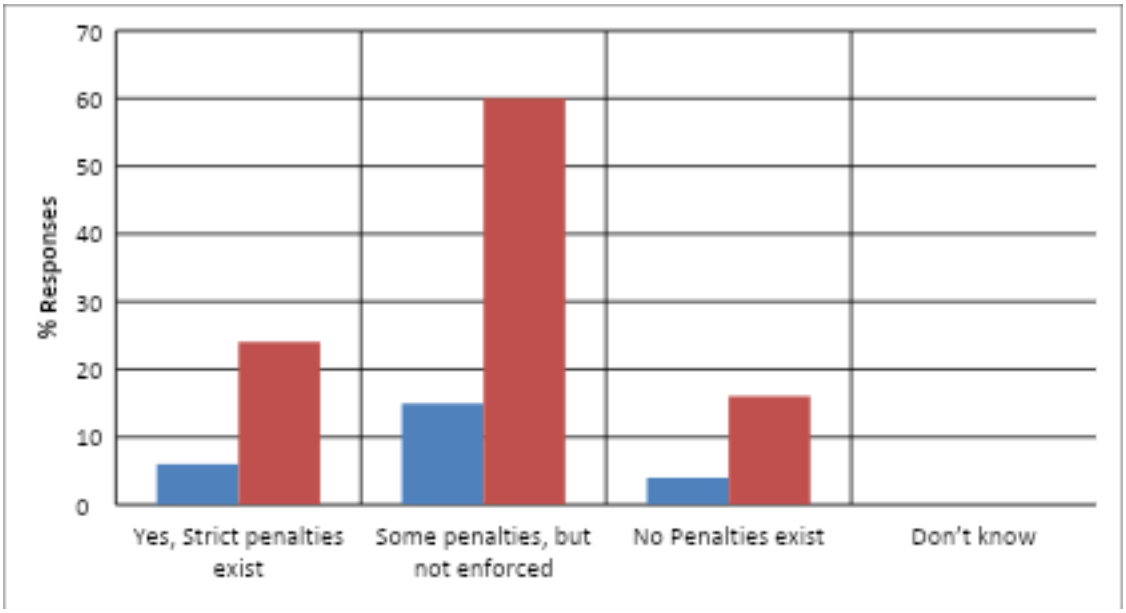


Fig. 18: Enforcement of waste handling penalties in Jos, Plateau State: Responses from MSW managers

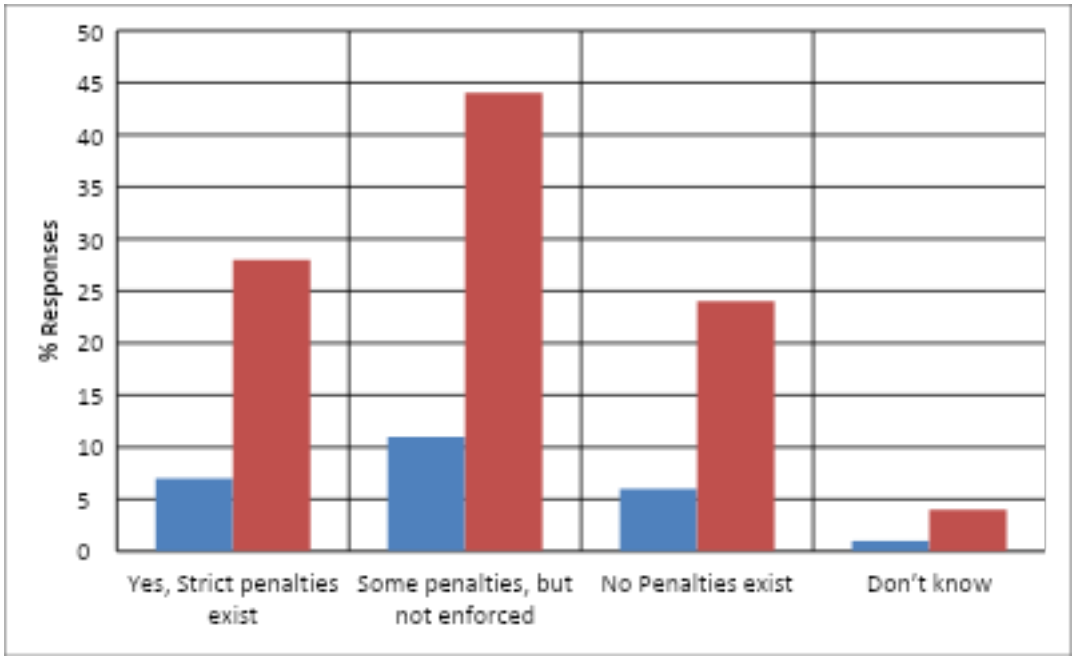


Fig. 19: Enforcement of waste handling penalties in the FCT, Abuja: Responses from MSW managers

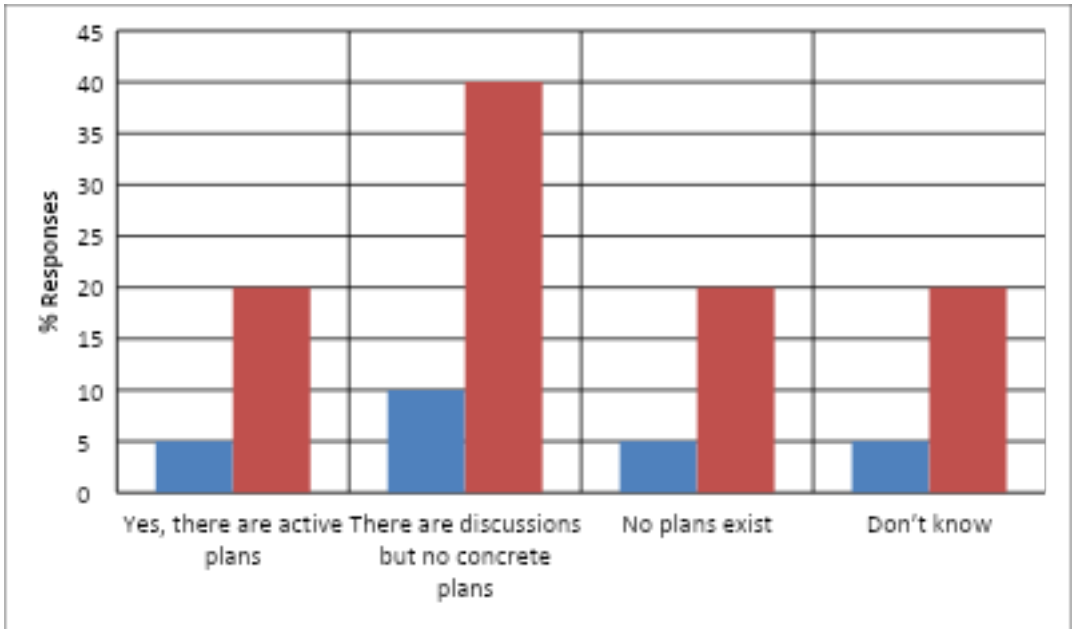


Fig.20: MSW staff's Level of knowledge of on-going composting initiative to encourage farmers in Benin City, Edo State

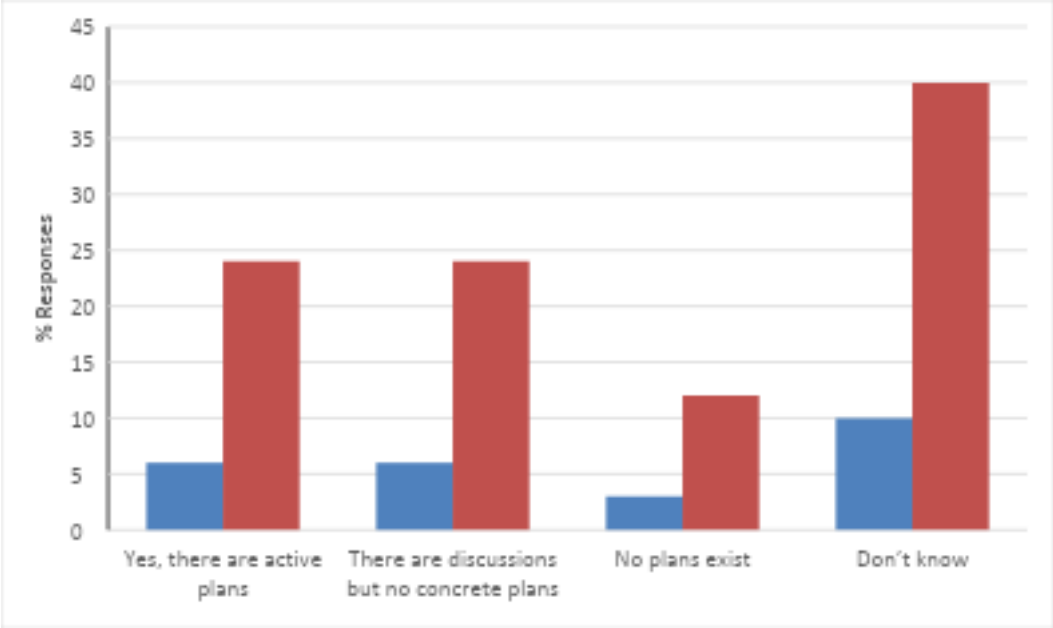


Fig.21: MSW staff's Level of knowledge of on-going composting initiative to encourage farmers in Epe, Lagos State

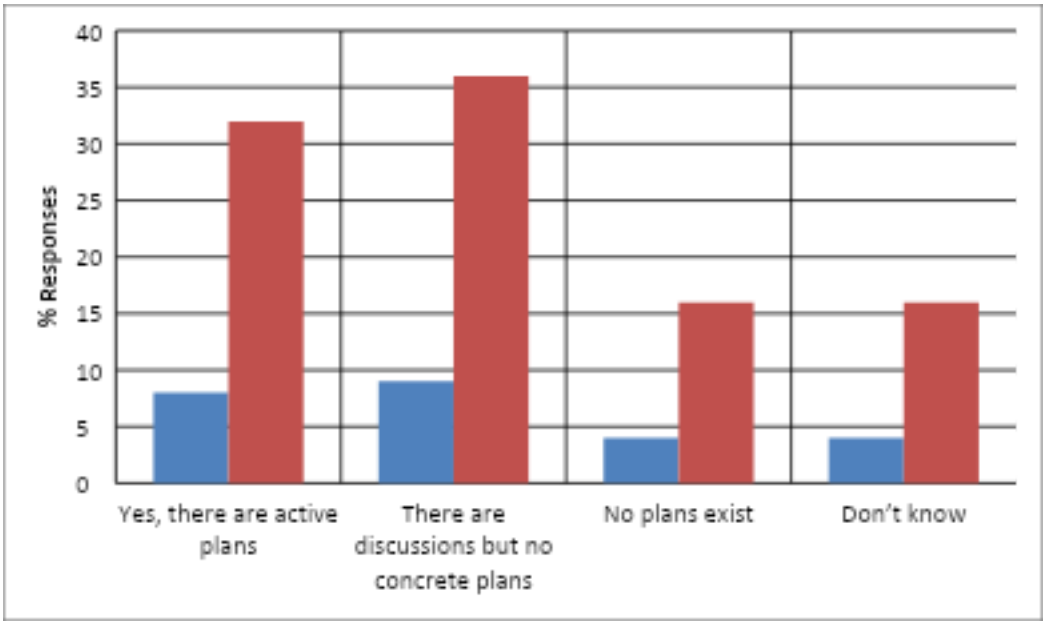


Fig.22: MSW staff's Level of knowledge of on-going composting initiative to encourage farmers in Jos, Plateau State

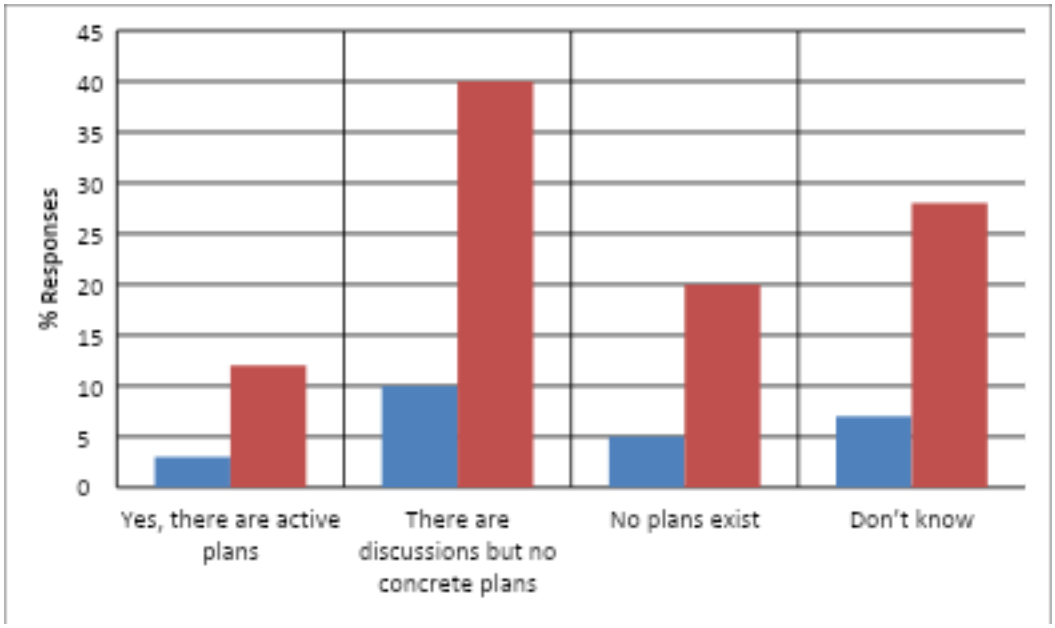


Fig.23: MSW staff's Level of knowledge of on-going composting initiative to encourage farmers in FCT, Abuja

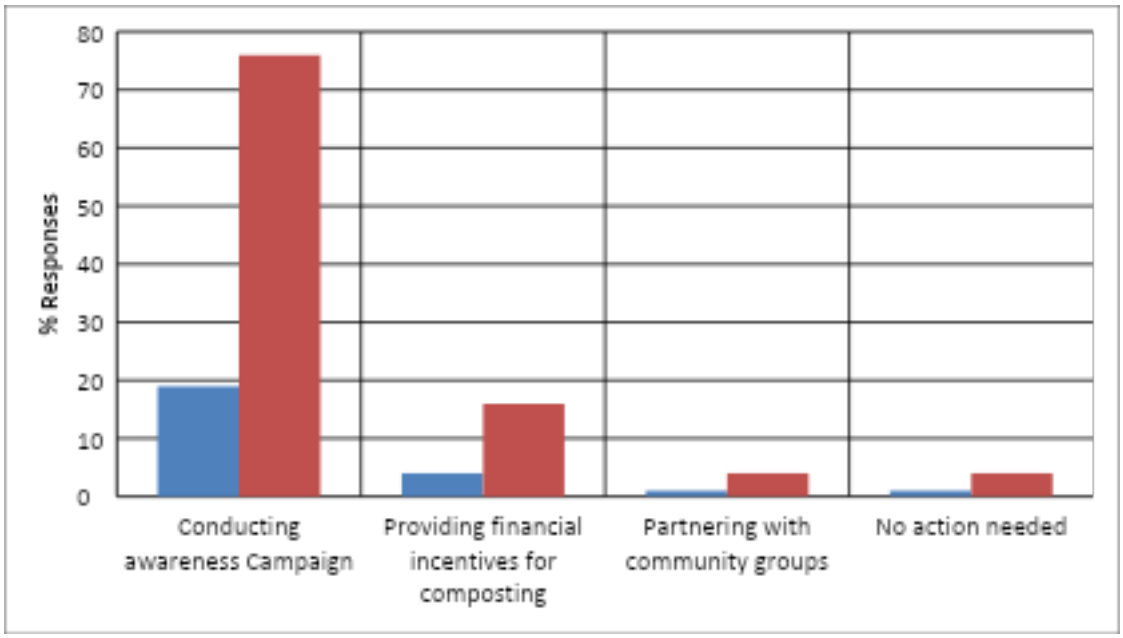


Fig.24: MSW official's Reponses to perceived ways government can sustain composting initiative in Benin City, Edo State

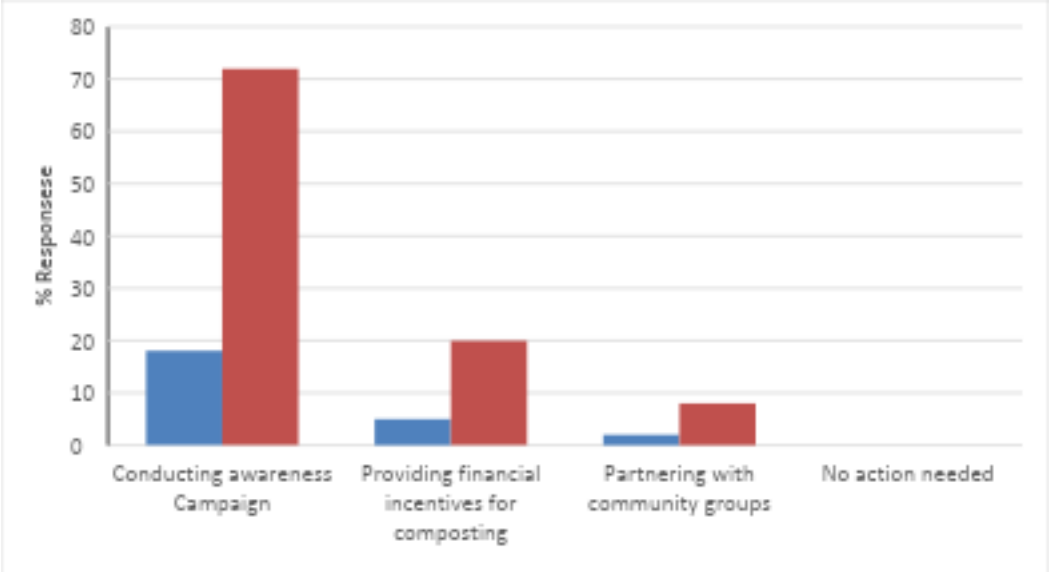


Fig.25: MSW official's Reponses to perceived ways government can sustain composting initiative in Epe Lagos State

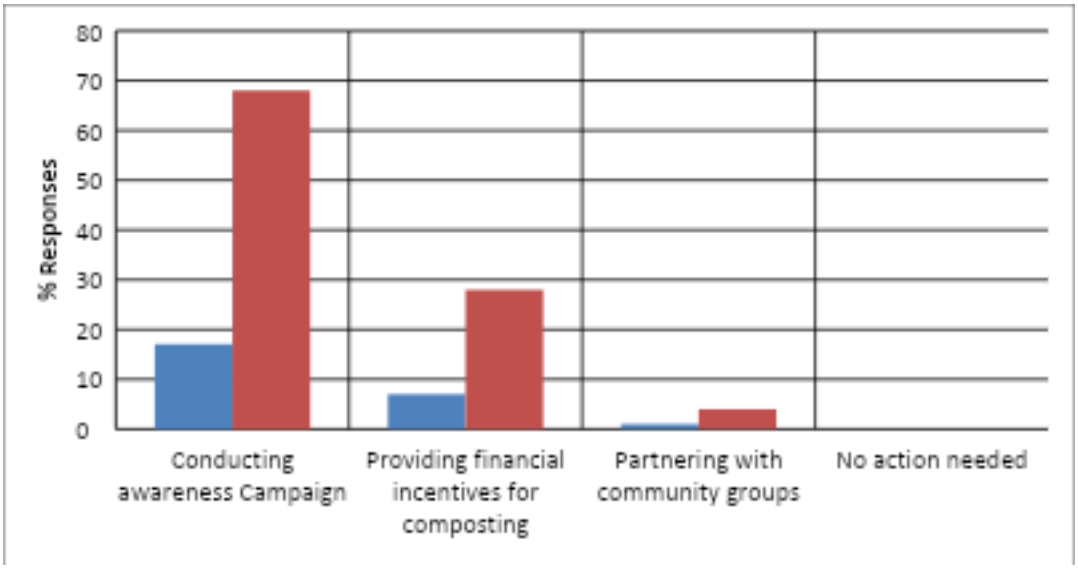


Fig.26: MSW official's Reponses to perceived ways government can sustain composting initiative in Jos Plateau State

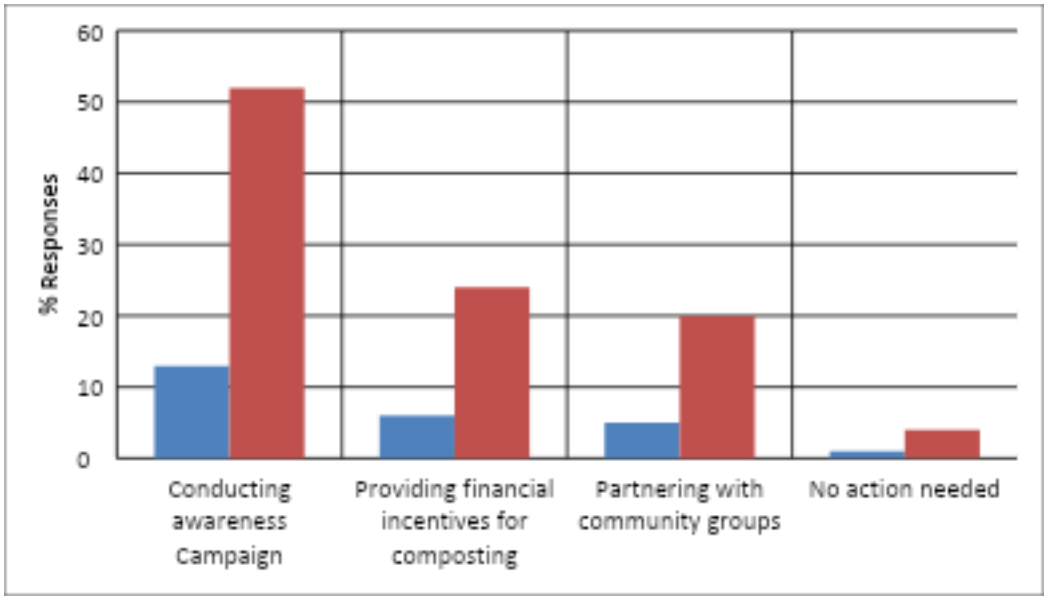


Fig.27: MSW official's Reponses to perceived ways government can sustain composting initiative in the FCT, Abuja

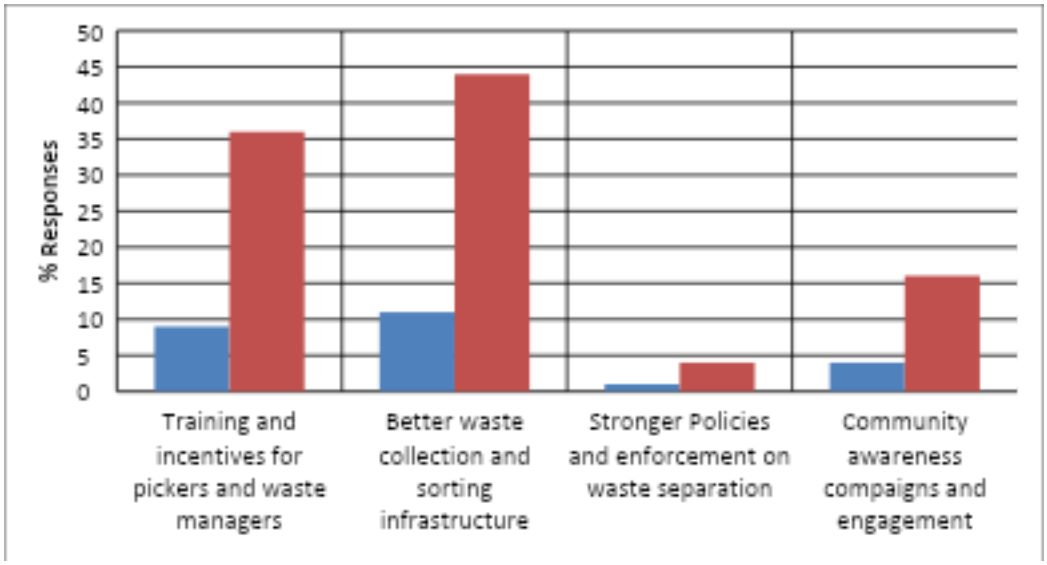


Fig. 28: Ways government can promote source segregation in Benin City, Edo State: Responses from MSW management officials

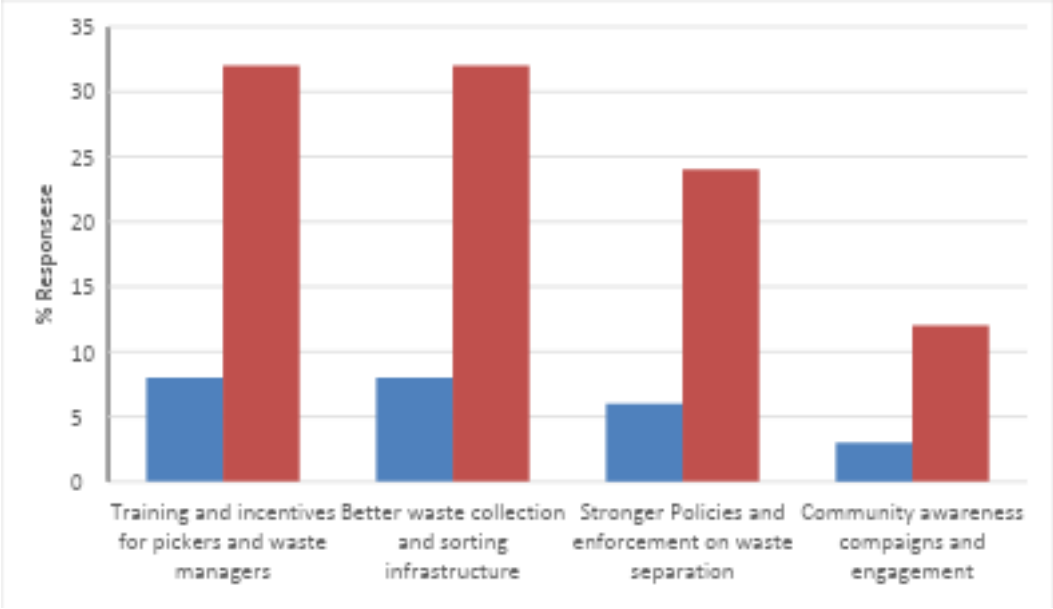


Fig. 29: Ways government can promote source segregation Epe, Lagos State: Responses from MSW management officials

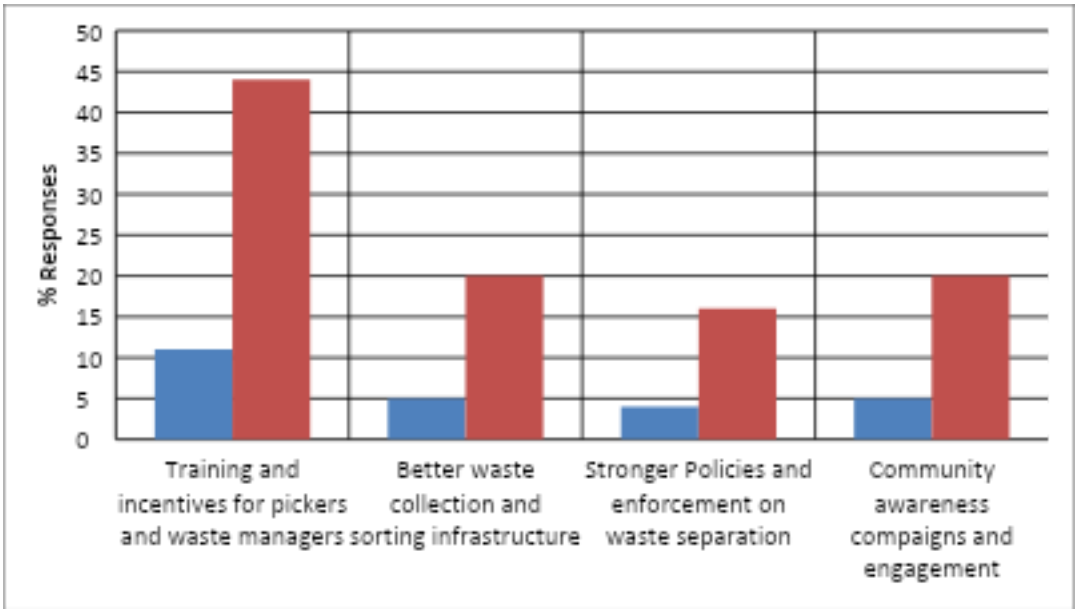


Fig. 30: Ways government can promote source segregation in Jos, Plateau State: Responses from MSW management officials

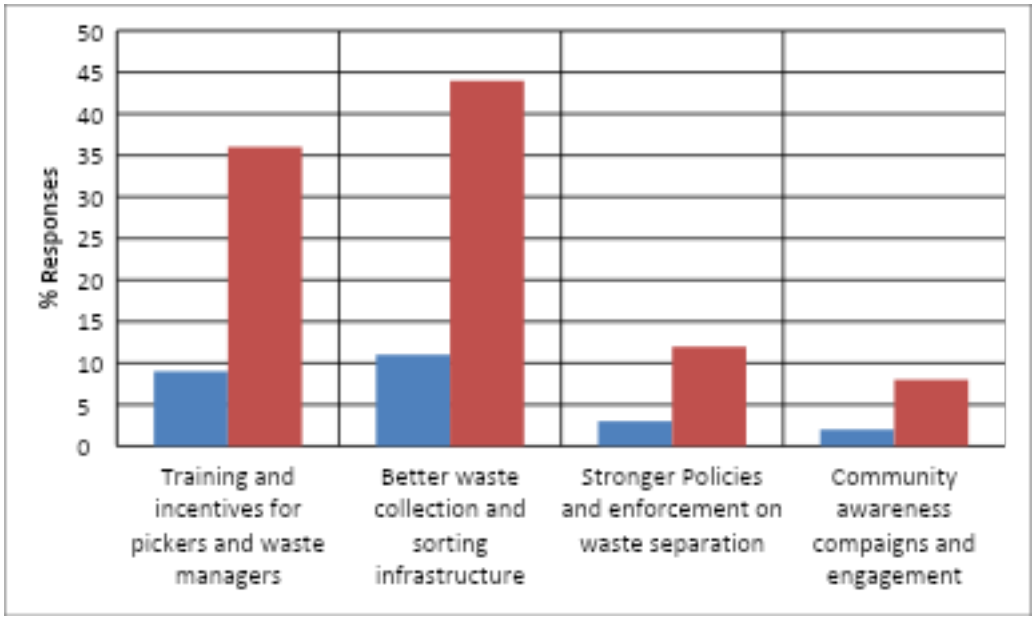


Fig. 31: Ways government can promote source segregation in the FCT, Abuja: Responses from MSW management officials

11.5. Baseline Results: Farmers' Views and Perceptions About Waste and Material Recovery Across Nigeria

Common crops cultivated by sampled Farmers

In Figs. 32 a-d, major crops cultivated in the sampled states and the FCT are presented. In Benin City, most of the farmers cultivate cash crops such as oil palm tree, mangoes, papaw etc (40%), tubers such as cassava, yam (44%) and others such as corn, pepper, Corn, beans, rice, peanuts, cashews, pineapples, tomatoes, eggplant etc. In Epe, Lagos State, most of the farmers cultivate vegetables, followed by fruits and tubers (24% respectively). In Jos town, vegetables were mostly cultivated (48%), followed by mixed crops (32%) and then Cereals/grains (16%). In the FCT, Cereals/grains are mostly cultivated (32%), followed vegetables and tubers (20% respectively). The Vegetable cultivated in these State include okra, spinach, pumpkin and root vegetable such as onions, carrot, while fish farming, poultry, piggery are main livestock farming. Vegetables, fruits waste and food waste from farm settlement are important sources of materials for composting and production of organic fertilizer. Figs. 31 a-d, are also indication of material availability and abundance. Currently, material recovery for recycling, mostly plastics, is a common practice in Nigeria, but not composting. Waste pickers serve as middlemen between waste generators and recycling companies Kano and Lagos for example. Salvaged recyclable materials are picked from these states and the FCT and, then stacked in big bags, and transported

to Lagos and other nearby parts of the country for recycling. Hence, both recycling of plastics and composting of organic waste are not practiced in Benin City, Lagos, Jos and the FCT, which further justify the need for the present MAMRN which is based on diverting organic waste from refuse stream through composting

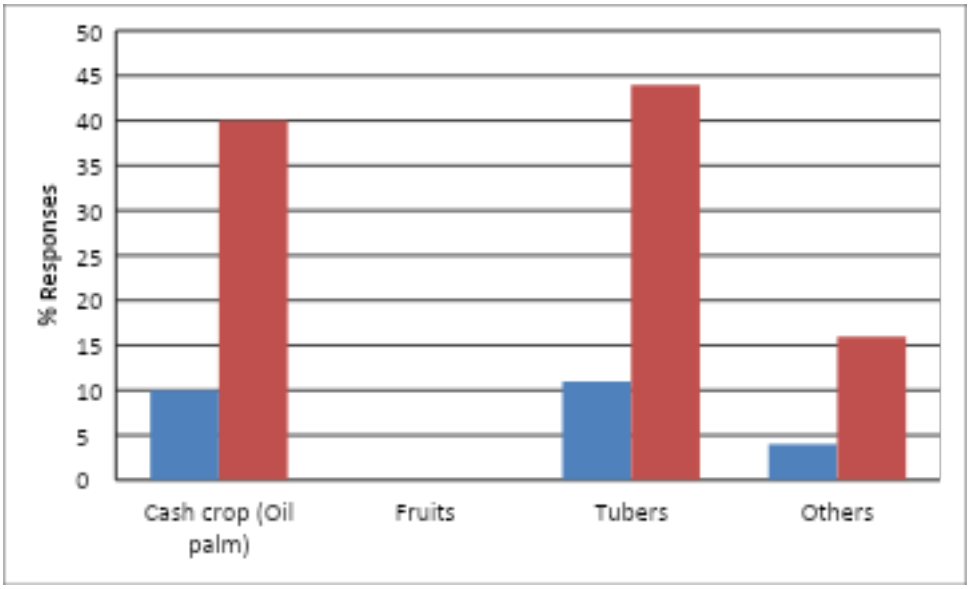


Fig. 32a: Common crops cultivated/farm types by sampled Farmers in Benin City, Edo State

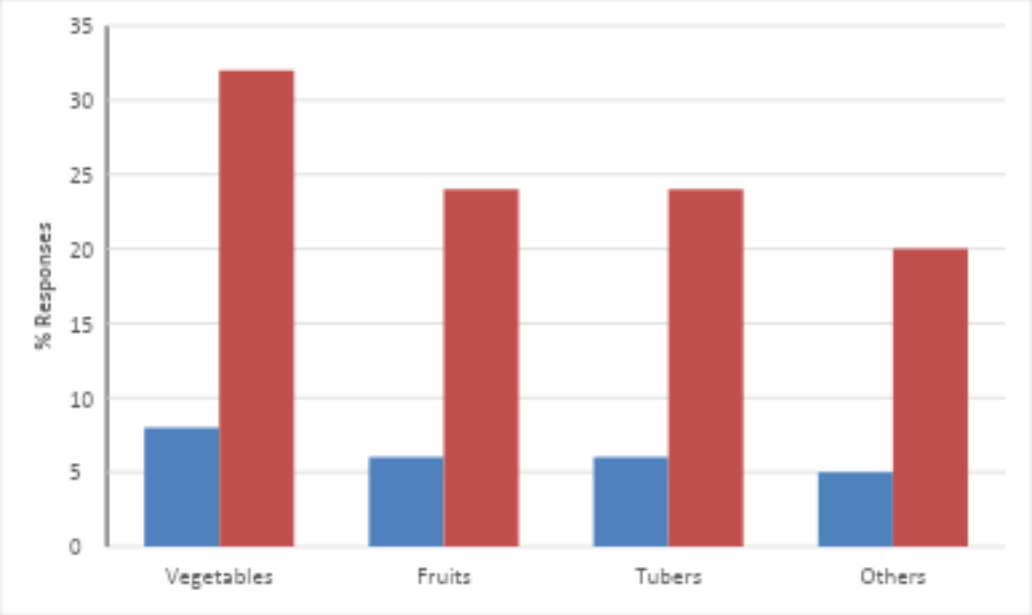


Fig.32b: Common crops cultivated/farm types by sampled Farmers in Epe community, Lagos State

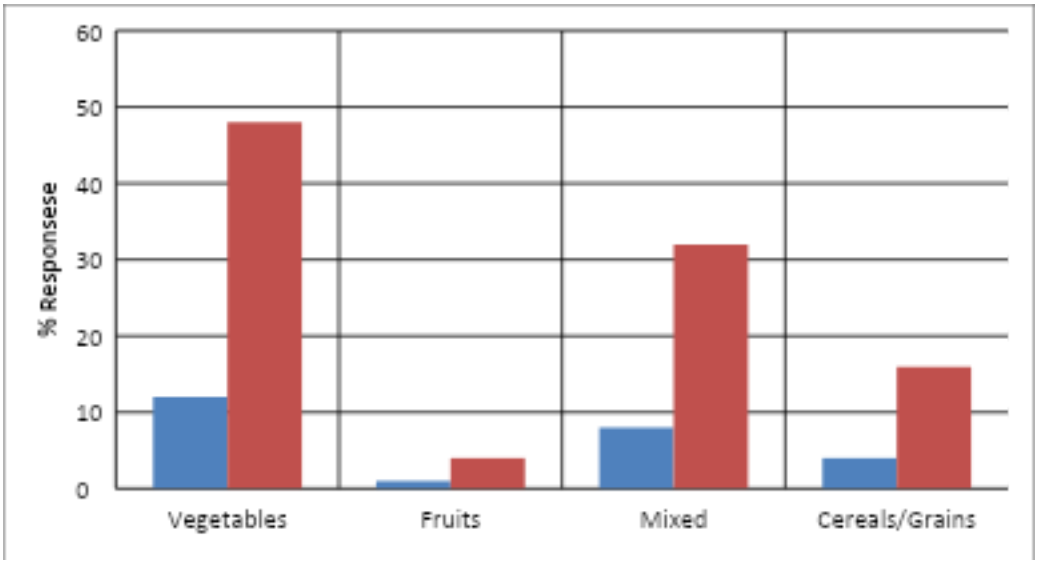


Fig.32c: Common crops cultivated/farm types by sampled Farmers in Jos, Plateau State

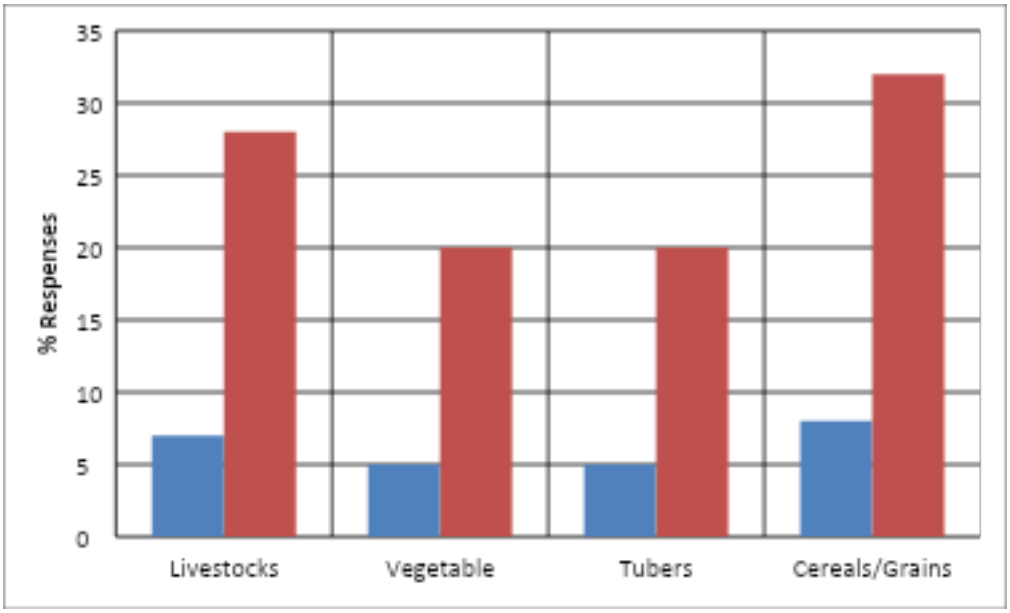


Fig.32d: Common crops cultivated/farm types by sampled Farmers in the FCT, Abuja

Waste Disposal Methods among Farmers

In Figs 33 a-d, waste disposal methods among farmers, in Edo State, majority of the farmers burn their farm waste when dry or simply heap the waste around crops, while others abadons their waste on the far. 12% of farmers in Benin city discard their waste indiscrimately citing lack of collection by authortues as excuse. In Epe town, Lagos State iregular collection and indiscriminate disposal charcterised waste handling by farmers. This is followed by heap the waste around crops and simply abandoing the waste on the farm. In Jos town, abandoing the waste on the farm is a common waste handling practice among farmers, while in the FCT, farmers practices both burning of dry waste, heap the waste around crops and simply abandoing the waste on the farm and indiscrimate disposal on empty lands/unapproved dumpsites. From Figs 32a-d, the percentage of organic waste indiscriminatly dunped on unapproved dumpsites or on the farms also represents material loss, as organic component when mixed with other fractions of waste in an open dumpsite may never be recovered. This indication of material loss also points to the strategic role of source segregation in the proposed MAMRN project. The successful implementation of Material Recovery Facility in Nigeria and the sustenance of the model to achieve its vision of zero waste depends on policy framework/implementation strategies and community's response to policies and sensitization programs on behavioural changes towards source segregation

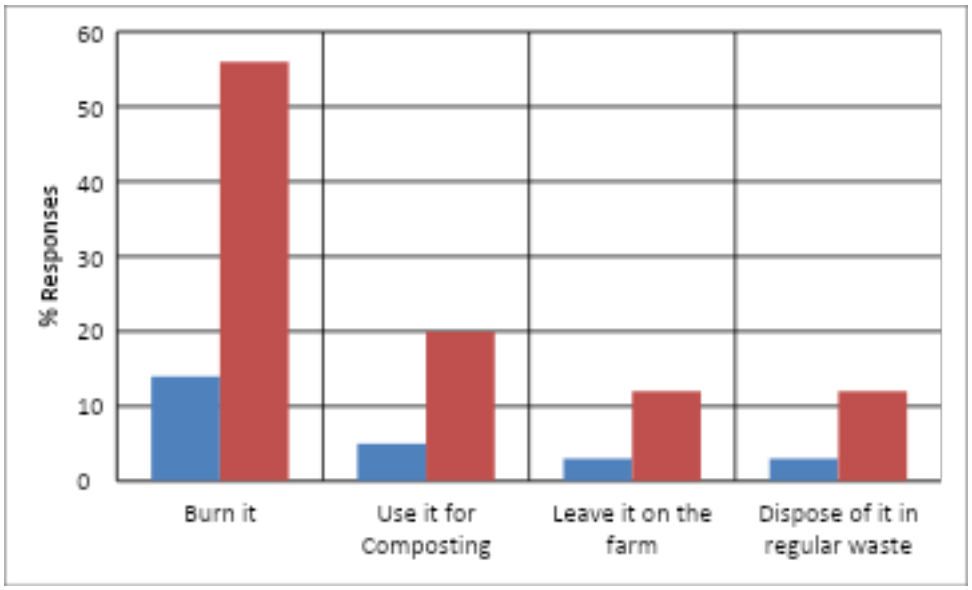


Fig. 33a: Organic waste disposal methods among farmers in Benin City, Edo State

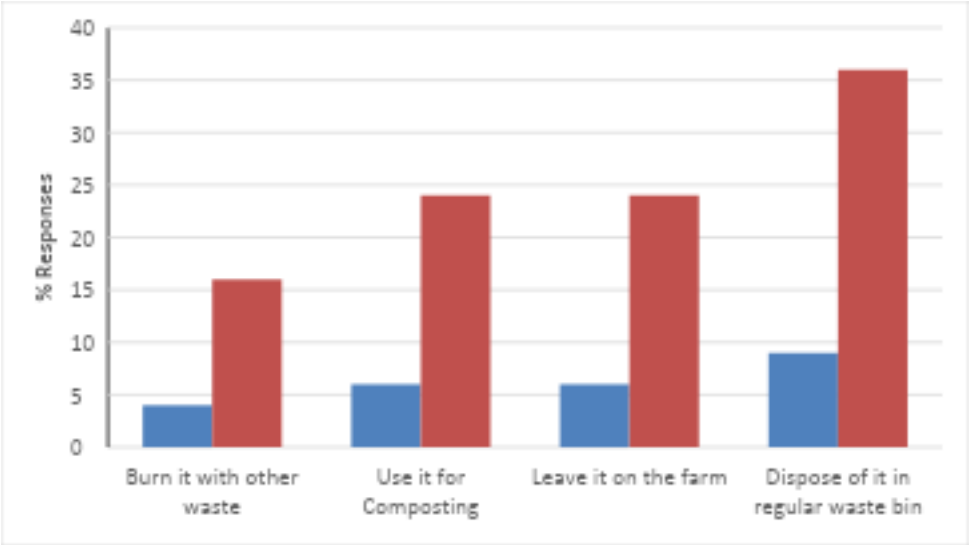


Fig. 33b: Organic waste disposal methods among farmers in Epe, Lagos State

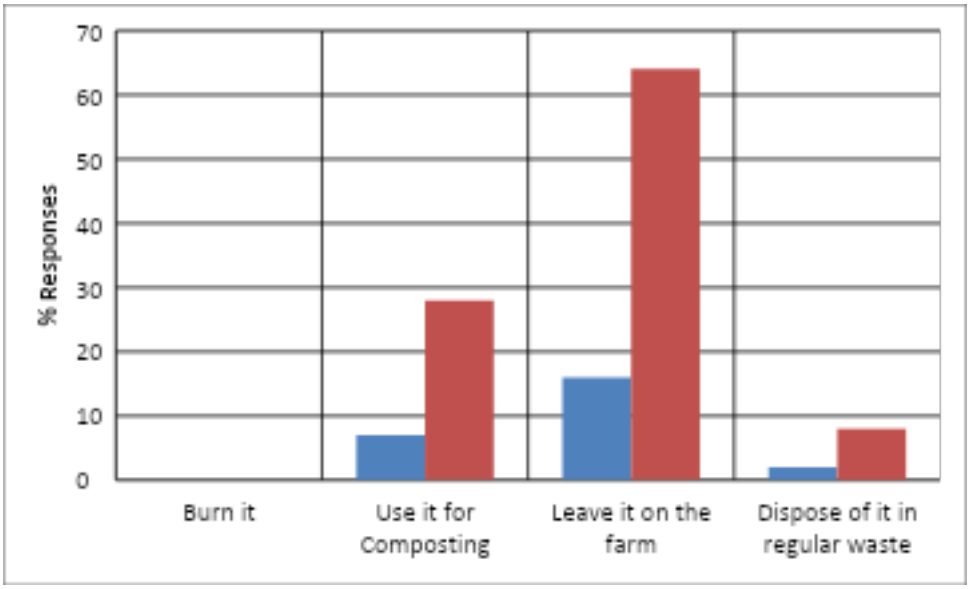


Fig. 33c: Organic waste disposal methods among farmers in Jos, Plateau State

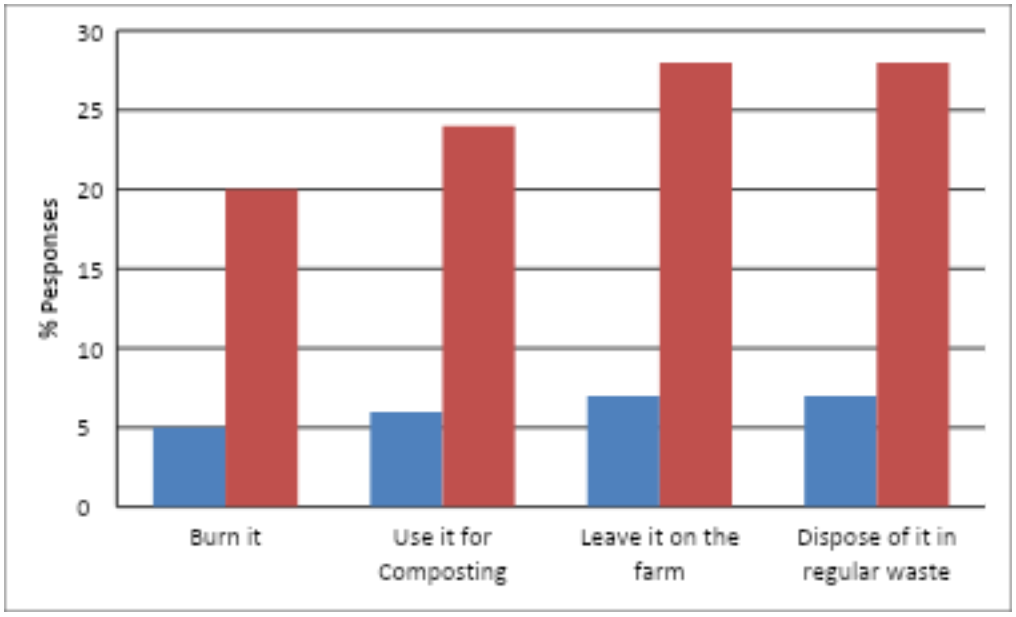


Fig. 33d: Organic waste disposal methods among farmers in the FCTs, Abuja

Types of Fertilizer in use by Farmers

In Figs. 34a-d, the types of Fertilizer in use by farmers in the sampled states and the FCT are presented. In Benin City, most of the respondents indicated that the use chemical fertilizer, while 16% indicated that they use organic fertilizer. The percentage of famers that use both in Benin City was 24% while 28% indicated that they do not use any form of fertiliser on their farms. Like situation in Benin City, application of chemical fertilizer is a common practice in Epe, Lagos, while only 16% use organic waste as alterative to chemical fertilizer. Another 24% use both chemical and organic fertiliser on their farms. In Jos town, majority of sampled farmers apply both chemical and bio-fertiliser, while in the FCT, both fertilizers are applied, while 24% of sampled farmers indicated that they do not use any form of fertiliser on their farms. Even the farmers that subscribed to the use of organic manure simply practice the dumping of left over decomposable waste and fruits waste as manure on their farmlands but do not practice composting. Composting goes beyond simply discarding leftover food on plant. To compost waste effectively, there is a combination of "green" (nitrogen-rich) and "brown" (carbon-rich) materials to maintain moisture and aeration, and choose a suitable composting method, like a compost bin, trench or Compost Pile etc.

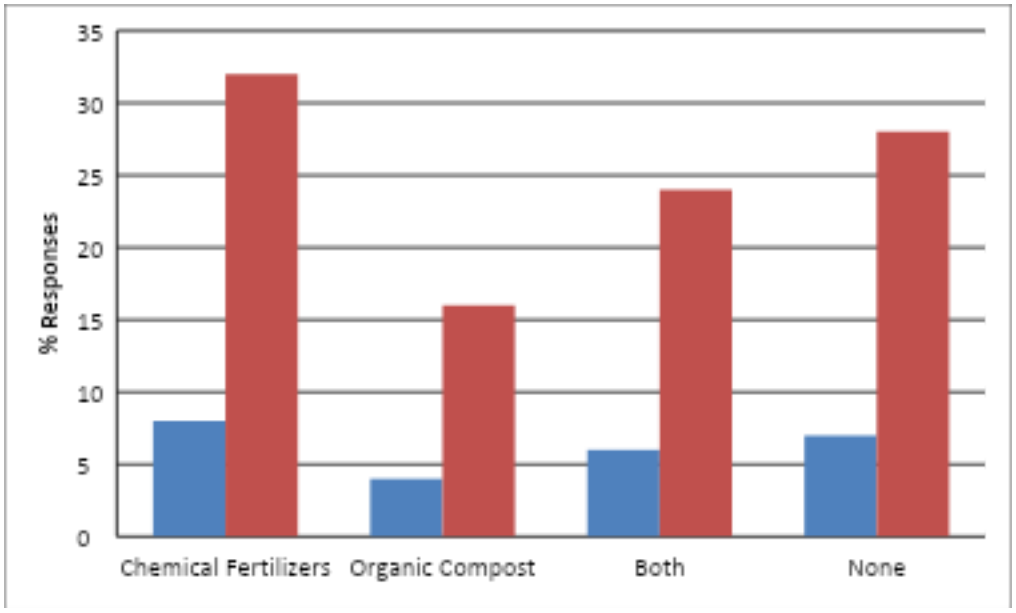


Fig. 34a: Types of Fertilizer in use by farmers In Benin City, Edo State

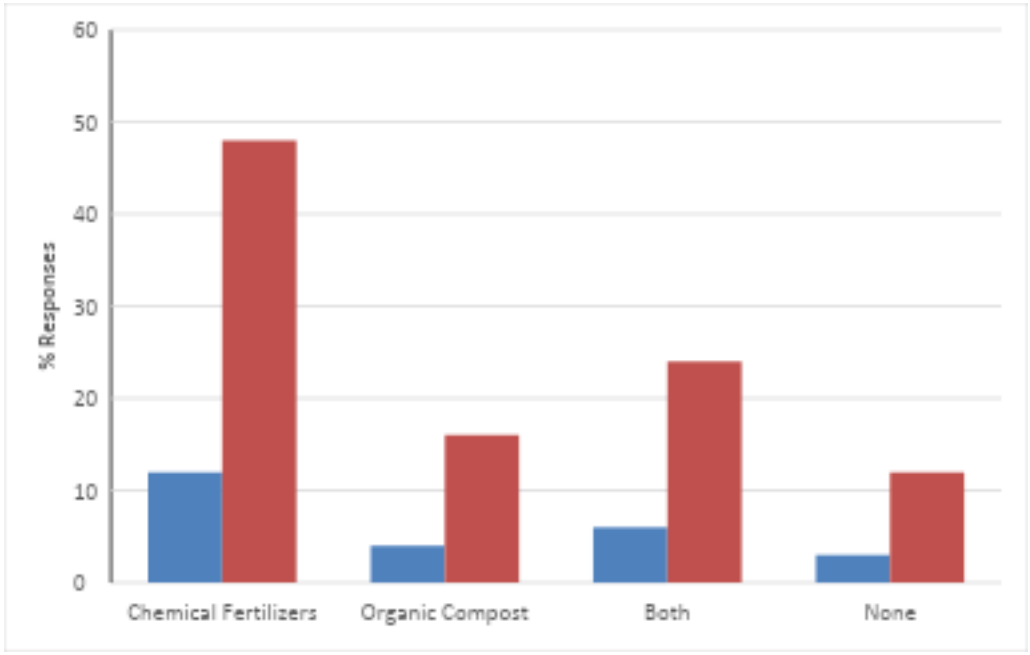


Fig. 34b: Types of Fertilizer in use by farmers In Epe, Lagos State

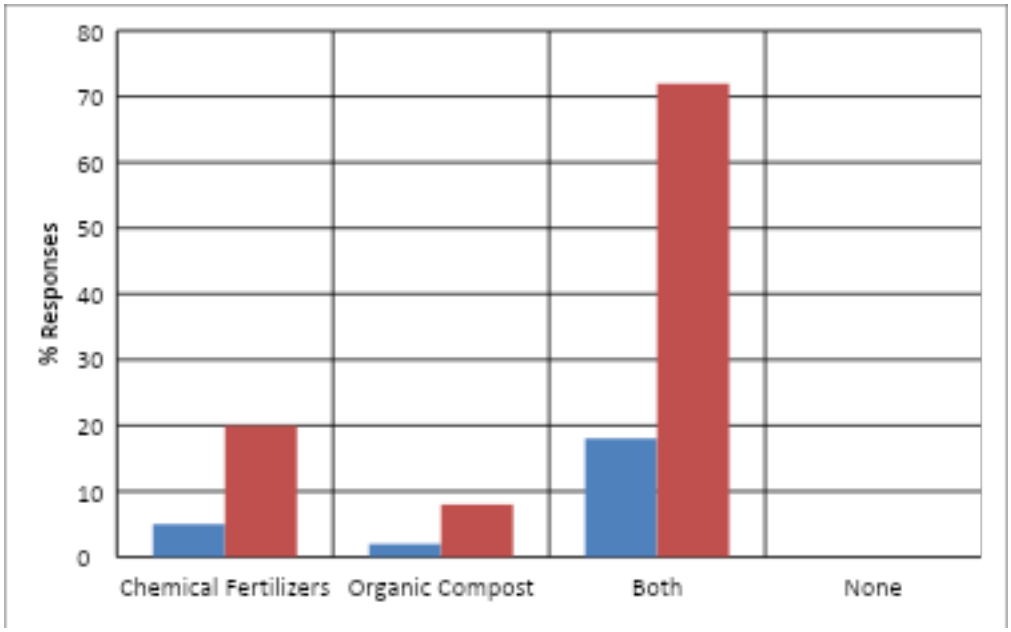


Fig. 34c: Types of Fertilizer in use by farmers in Jos, Plateau State

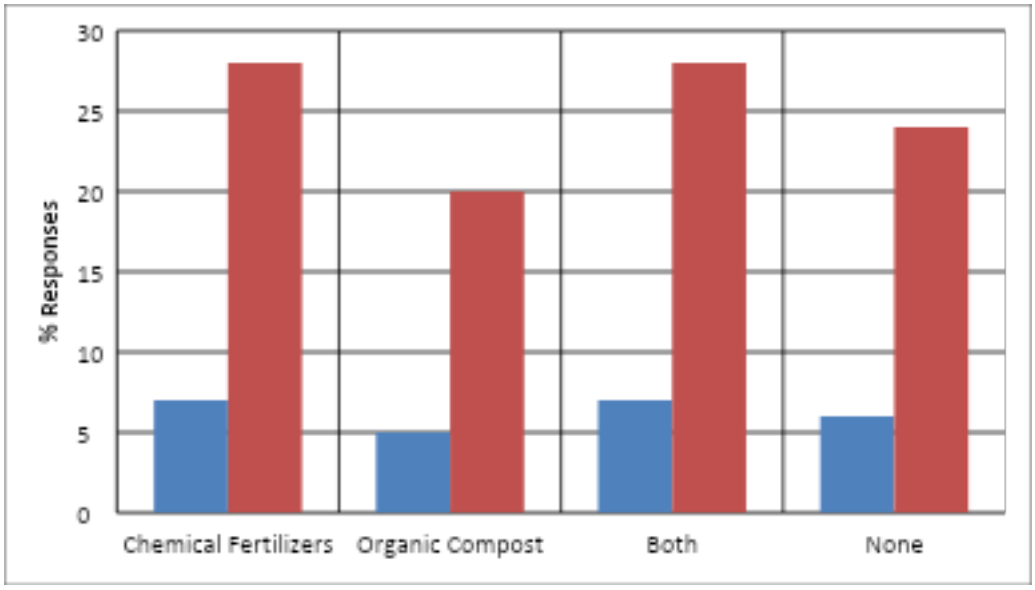


Fig. 34d: Types of Fertilizer in use by farmers in the FCT, Abuja

Reasons for Low use of Organic Fertiliser

On why farmers are not composting and or use bio-fertiliser on their farms, (Figs 35a-d), about 50% of the respondents in Benin City indicated that bio-fertilizer will be expensive given that the quantity required for their farm operation will be much, another 42% indicated that they do not have an understanding of how to compost. Another 8% indicated that organic fertilizer is not

sold around their localities. In Epe, Lagos State, the majority (46.2%) do not understand the processes require for composting, while farmers who are willing to compost indicated that the initial capital of building a composting bay is expensive. More so, since some of the farmers reside in rented apartment erecting a composting facility will depend on the approval of the house owner. In Jos Town, poor knowledge of the process of composting was rated highest (52%), followed by respondents that indicate that even though they are willing to buy already made organic fertiliser, they have no knowledge of where to buy it. In the FCT, Abuja, many farmers showed willingness to switch to composting but lack the knowledge of the process, while other respondents (farmers) in the FCT indicated that even though the would love to buy organic fertiliser, there exist not market for it at the moment. The observations from Figs 35 underscore the critical importance of promoting more sensitization programmes especially in local dialects and training on the importance and process of composting from organic waste. The poor knowledge of composting amongst farmers is further buttressed in Figs. 36a-d. For all the state surveyed, it can be seen that farmers wither do not know anything about the technicalities/processes involved in compositing or have very little or some knowledge of the processes. Of the farmers that indicated they have some knowledge of this process, non at the moment is practicing composting in their farms. In the FCT, Abuja, majority of the farmers lack the knowledge of the technicalities involved in composting when compared with observation in other states. For the farmers that have some knowledge of composting process, this knowledge is borne out from the native knowledge that decayed food and fruits items are rich in organic matter, and also useful for soil-plant nutrient exchange. So what farmers do is simply to throw organic waste directly on their farms, which does not translate to composting in real sense. An effective compost pile or trench needs a balance of carbon-rich materials (like dry leaves and shredded paper) and nitrogen-rich materials (like food scraps and grass clippings). Composting also requires maintenance of moisture and aeration ratio. In other words, the compost pile or bin must be kept moist and not soggy, as well as ensure the pile has enough air circulation by turning it regularly. In Jos, for example what is common is the burring of dried organic waste at dumpsites and later used as composting. This practice cannot also be considered as organic fertilizer as important micro-organisms would have been killed during the burning of the waste.

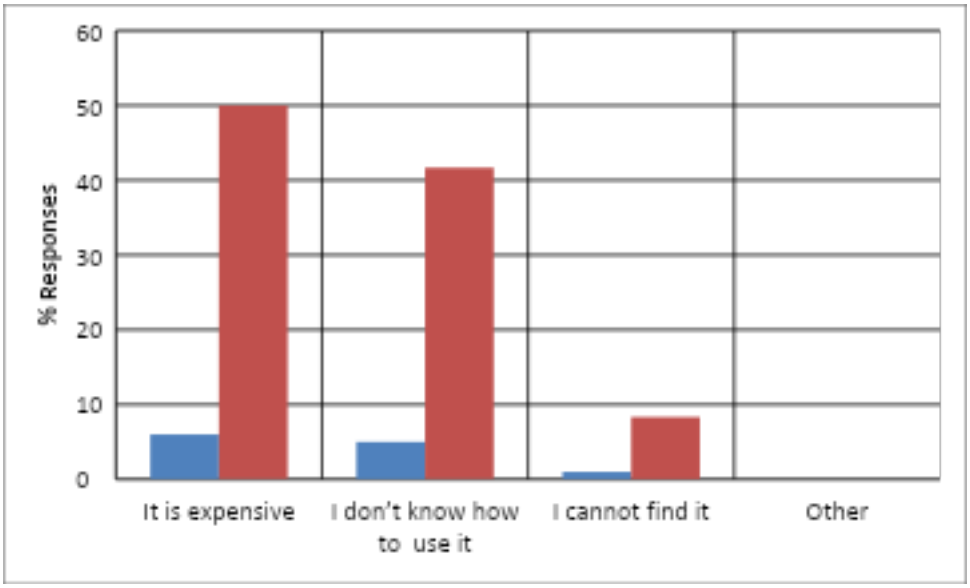


Fig. 35a: Farmer's reasons for low use of organic fertilizer in Benin City, Edo State

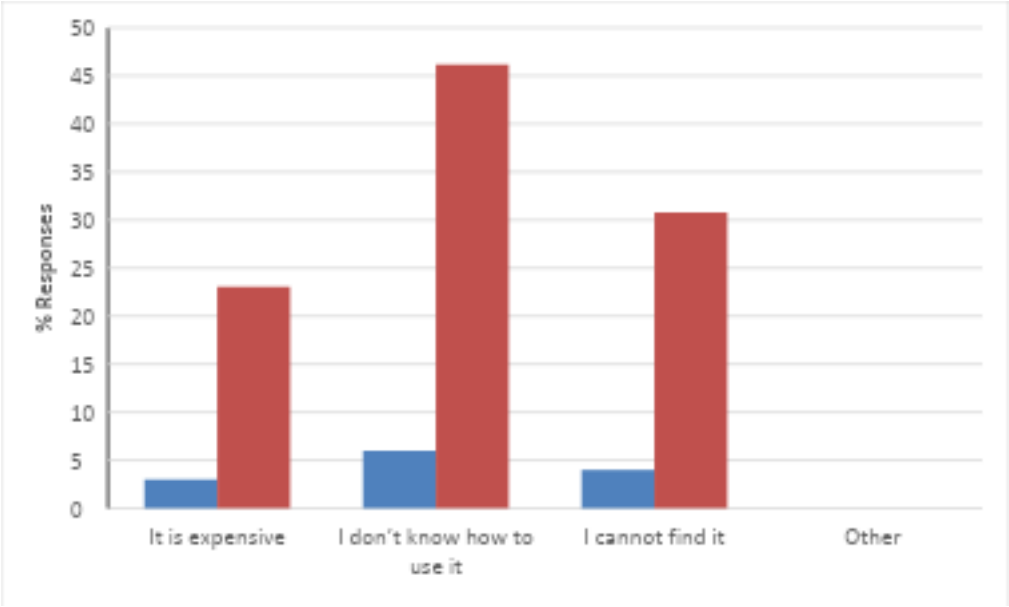


Fig. 35b: Farmer's reasons for low use of organic fertilizer in Epe, Lagos State

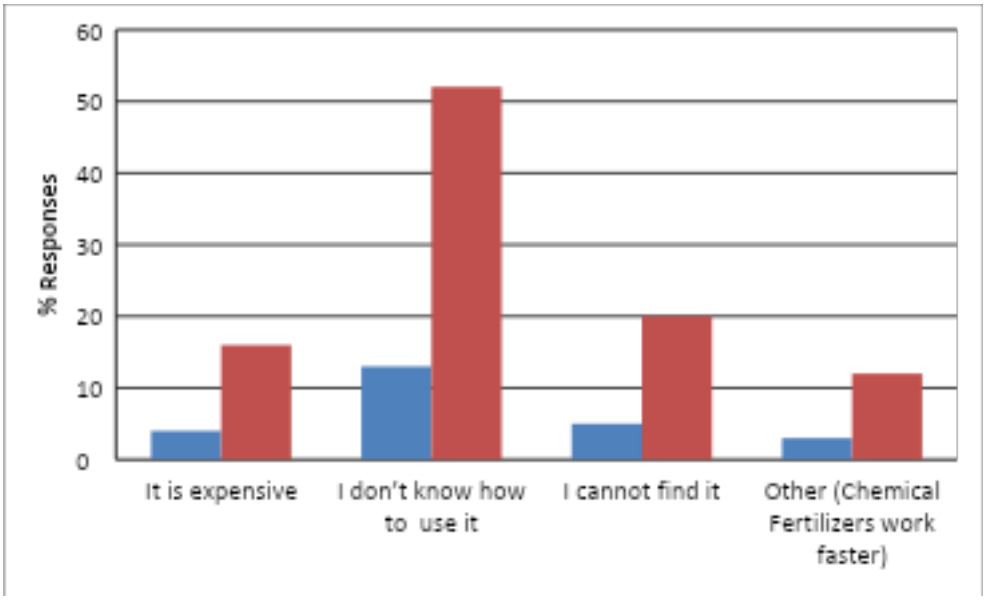


Fig. 35c: Farmer's reasons for low use of organic fertilizer in Jos, Plateau State

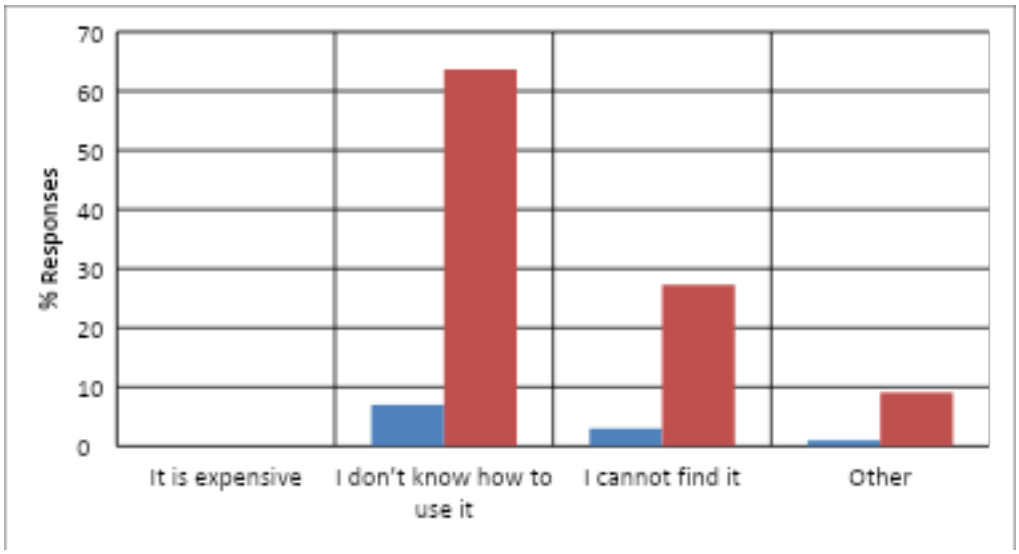


Fig. 35d: Farmer's reasons for low use of organic fertilizer in the FCT, Abuja

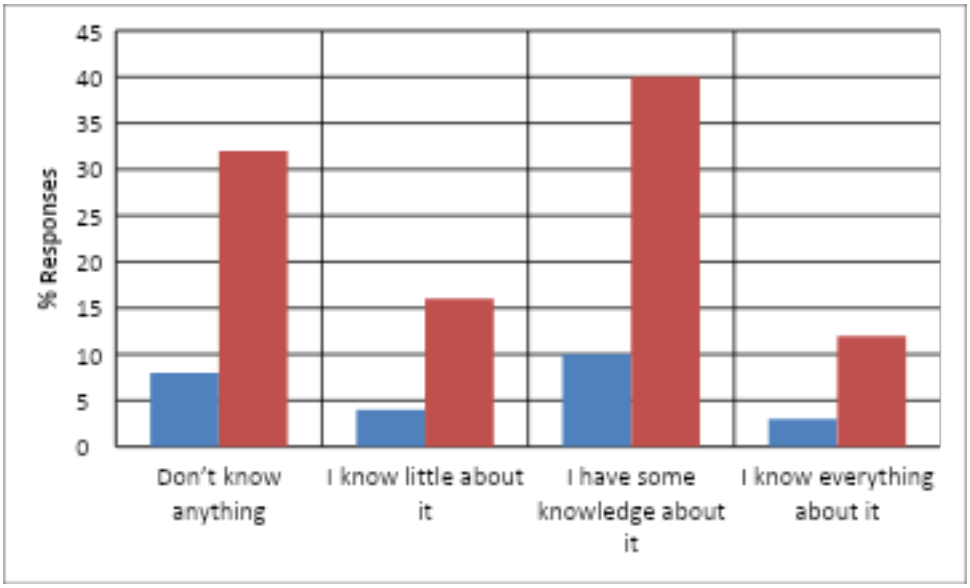


Fig. 36a; Farmer's Knowledge of composting process in Benin City, Edo State

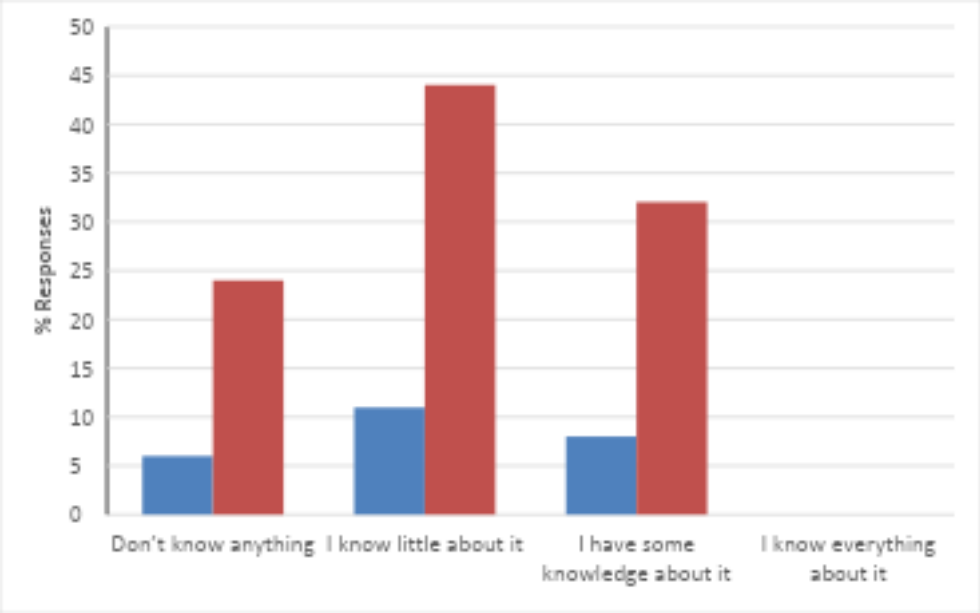


Fig. 36b: Farmer's Knowledge of composting process in Epe, Lagos State

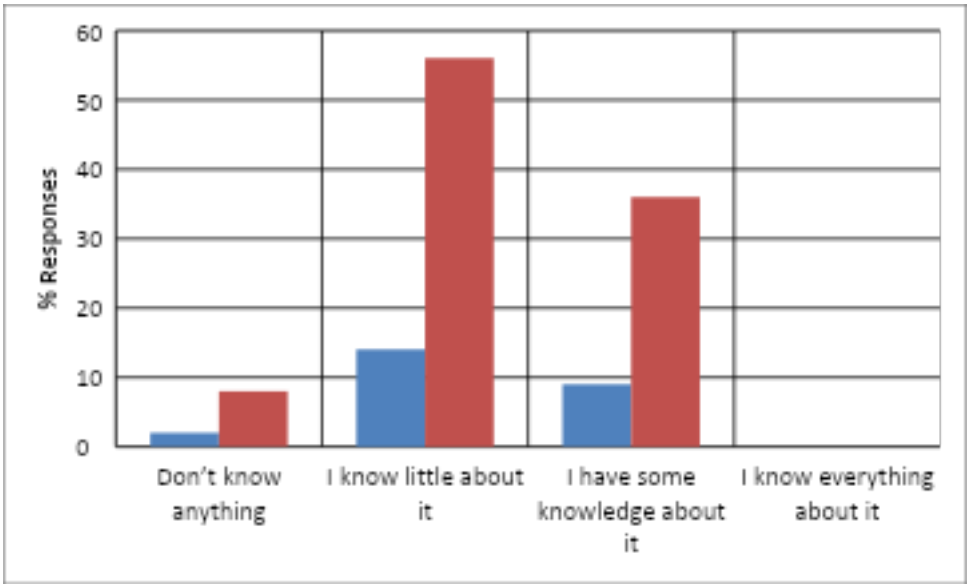


Fig. 36c: Farmer's Knowledge of composting process in Jos, Plateau State

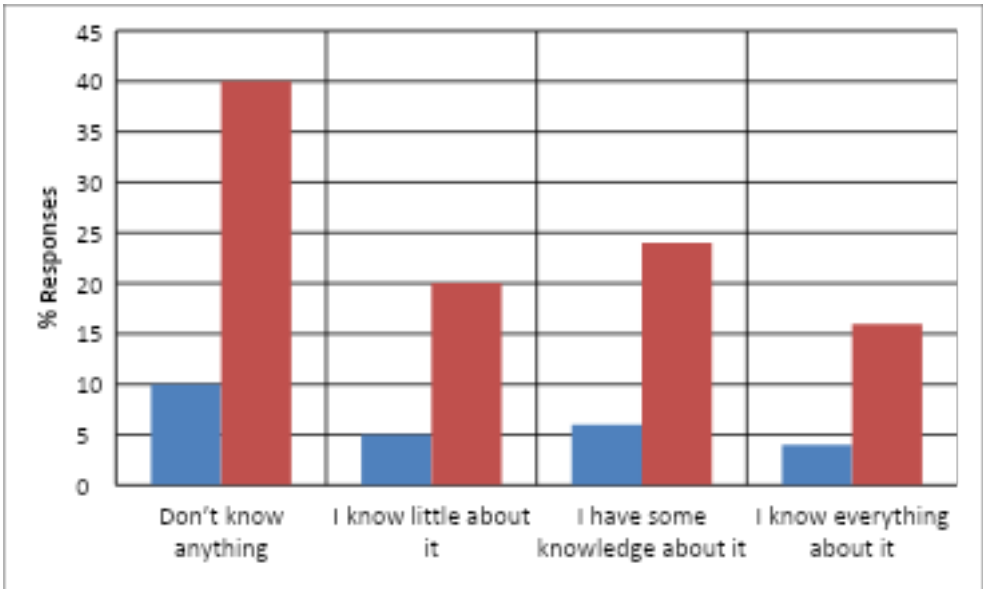


Fig. 36d: Farmer's Knowledge of composting process in the FCT, Abuja

Farmer's Perception on Economic Benefits of Bio-fertilizer

In Figs. 37a-d, farmer's perception on economic benefits of bio-fertilizer is presented. In Benin City, Epe, Lagos State and partly in the FCT, surveyed farmers indicated that bio-fertilizer will have major economic benefits as switching to bio-fertilizer will help then save money which would have been spent on chemical fertiliser. However, in Jos Town, majority of sampled

farmers are either neutral or disagree with the idea of economic benefits derivable from bio-fertilizer. For the farmers who are either neutral os disagree, their reasons include that chemical fertiliser make better crop production and though may be more expensive farmers considered the speed of nutrient delivery, ease of application, as key other advantages.

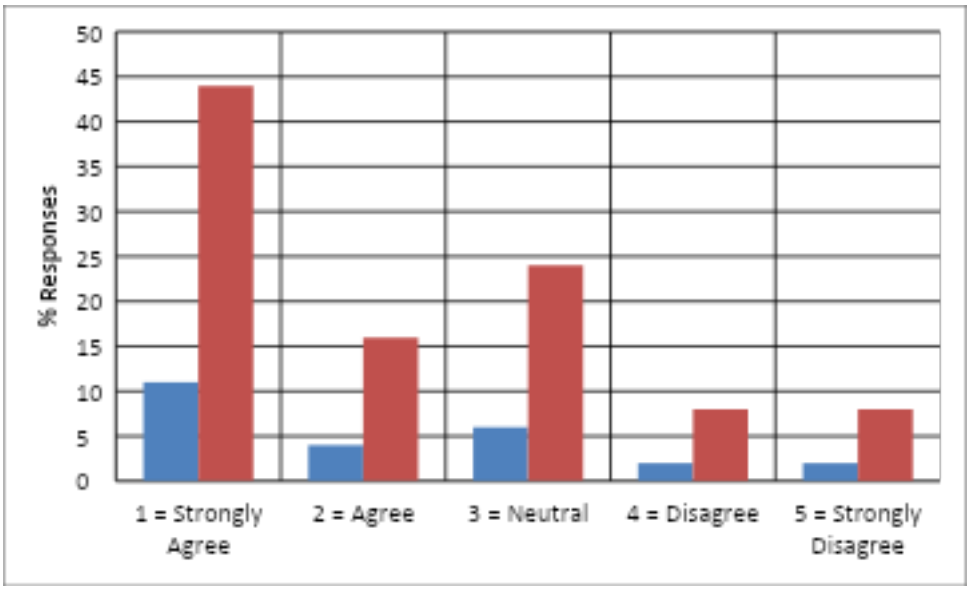


Fig. 37a: Farmer's Perception on Economic Benefits of Bio-fertilizer in Benin City. Edo State

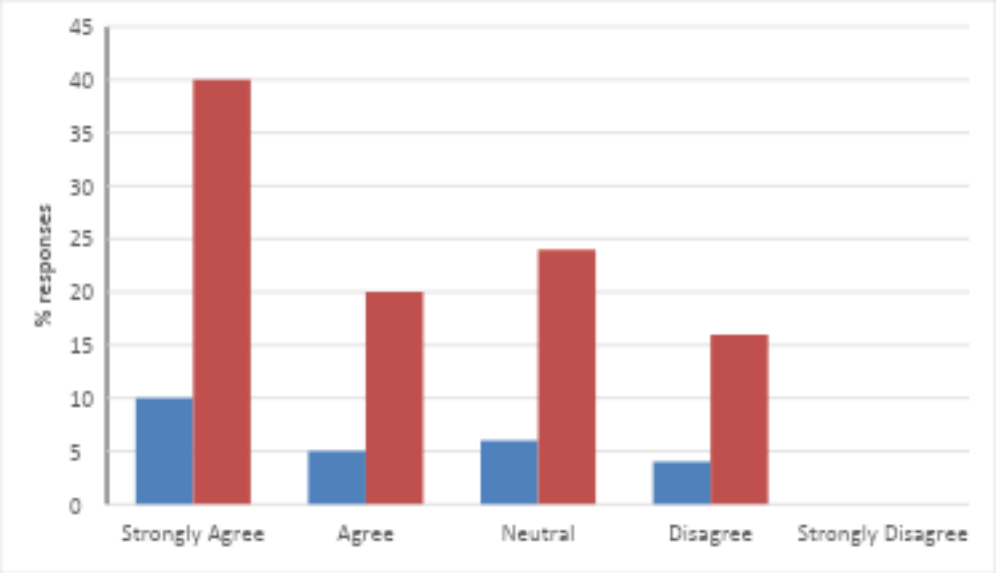


Fig. 37b: Farmer's Perception on Economic Benefits of Bio-Fertilizer in Epe community. Lagos State

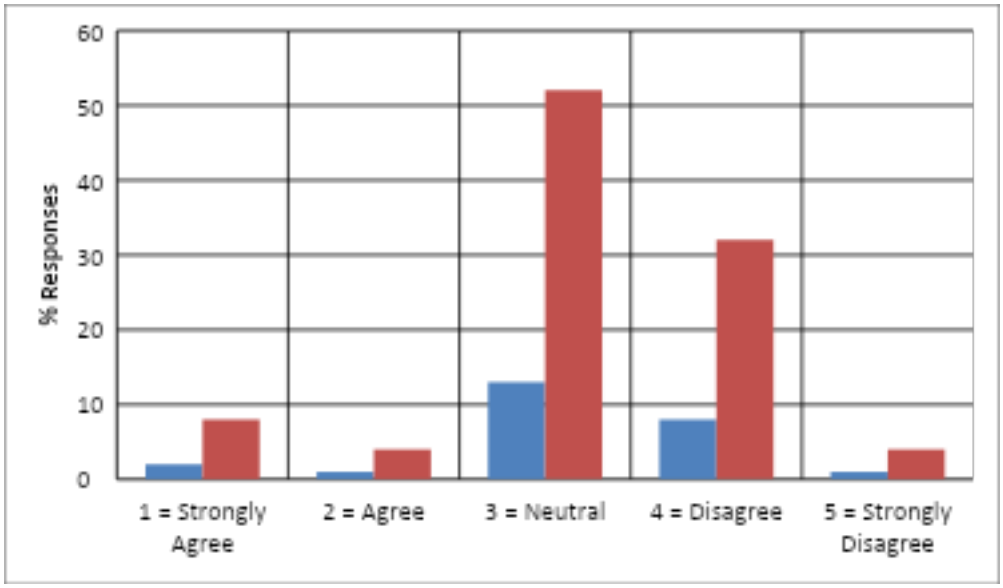


Fig. 37c: Farmer's perception on economic benefits of bio-fertilizer in Jos town, Plateau State

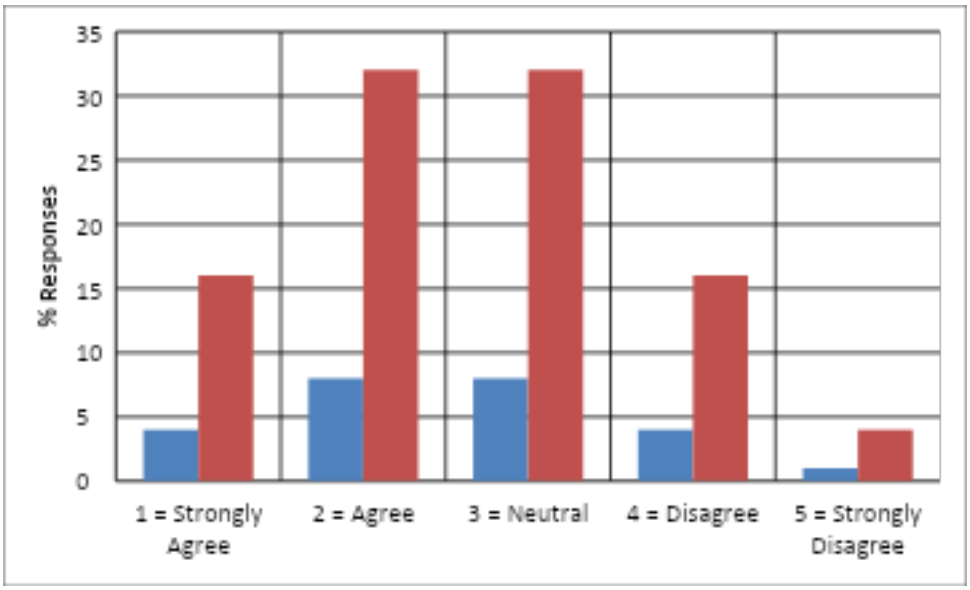


Fig. 37d: Farmer's Perception on Economic Benefits of Bio-fertilizer in the FCT, Abuja

Willingness to switch to Organic Fertilizer/Bio-fertilizer

Figs. 38a-d also illustrates farmer's willingness to switch as well as willingness to pay for organic fertilizer if available (39a-d). These responses emanate from the perceived environmental effects of chemical fertilizer use and the fact that the majority of sampled farmers are certain that incentive and subsidizing of organic fertilizer will increase it preference over chemical fertilizer (40a-d).

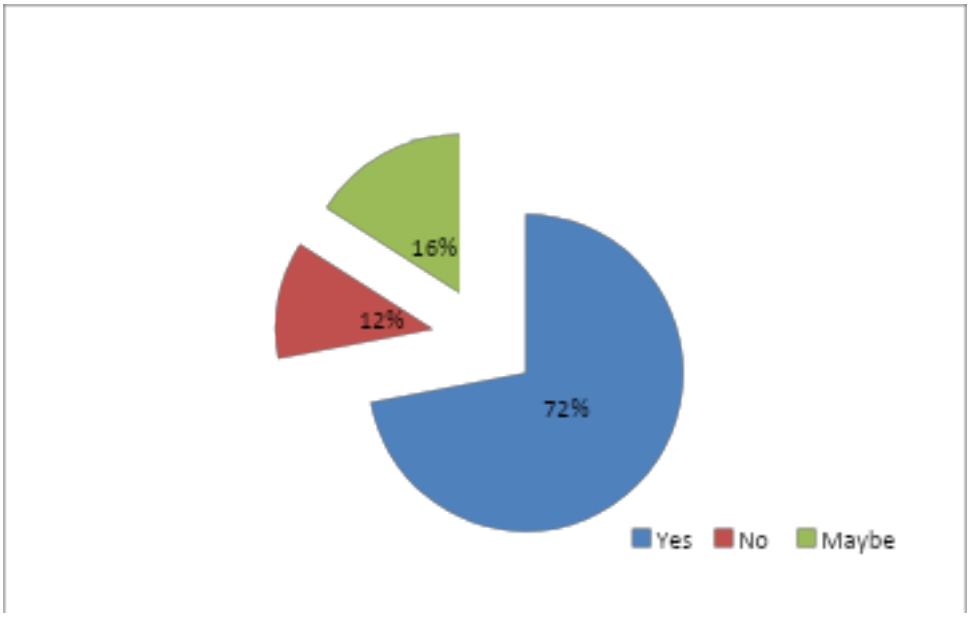


Fig. 38a: Willingness to switch to organic fertilizer/bio-fertilizer in Benin City, Edo State

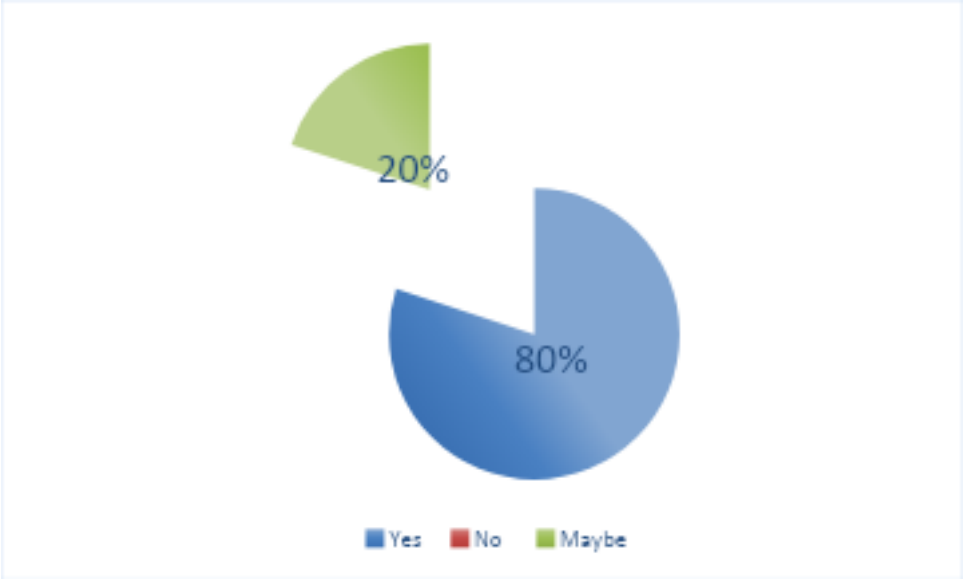


Fig. 38b: Willingness to switch to organic fertilizer/bio-fertilizer in Epe, Lagos State

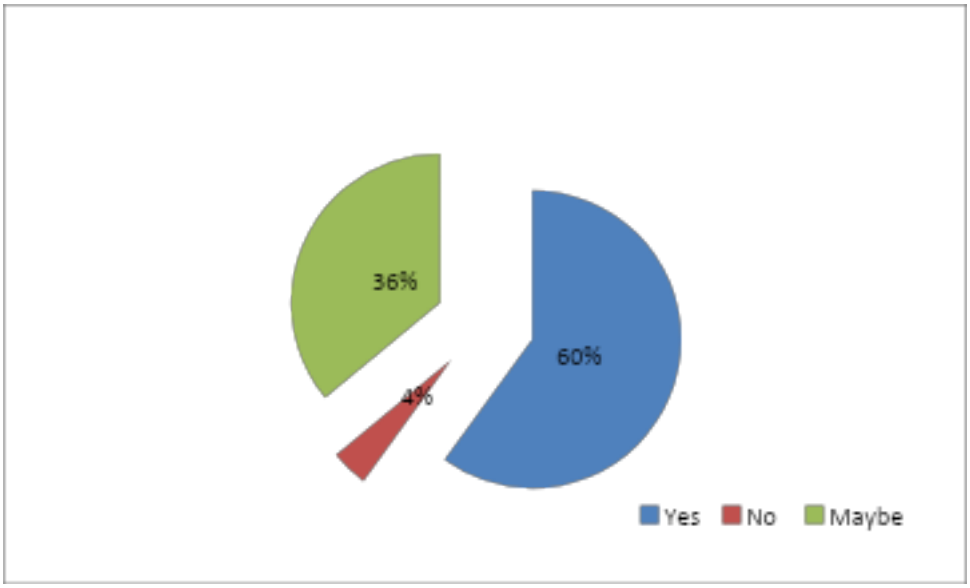


Fig. 38c: Willingness to switch to organic fertilizer/bio-fertilizer in Jos town, Plateau State

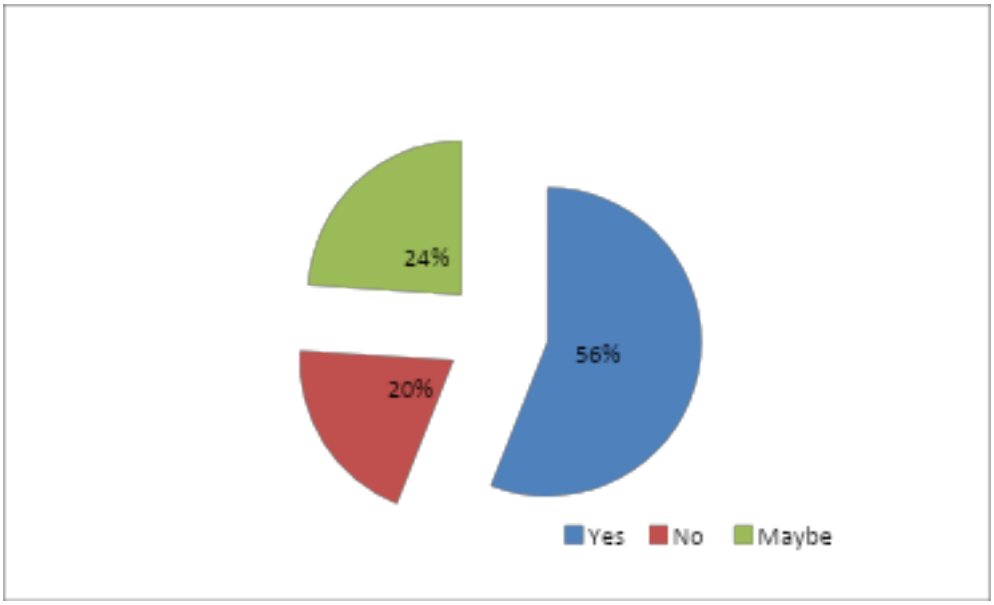


Fig. 38d: Willingness to switch to organic fertilizer/bio-fertilizer in the FCT, Abuja

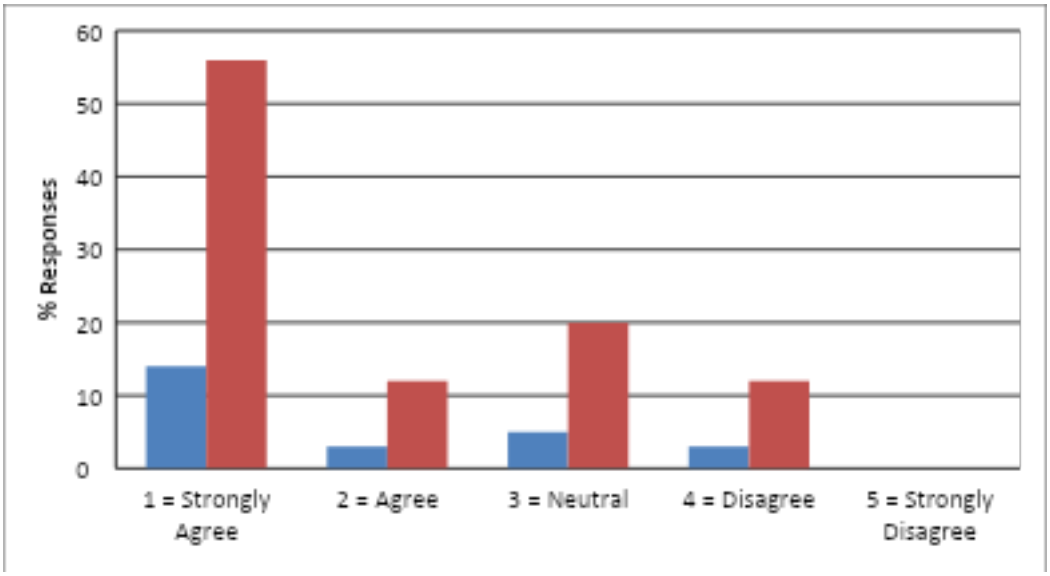


Fig. 39a: Farmer's willingness to pay for bio-fertilizer if available from MRF in Benin City, Edo State

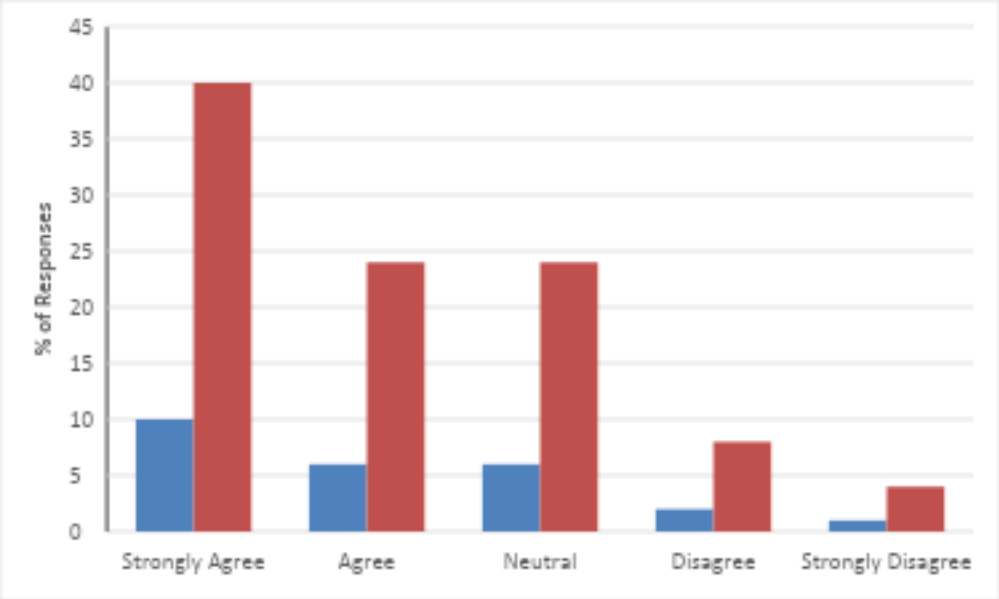


Fig. 39b: Farmer's willingness to pay for bio-fertilizer if available from MRF in Epe, Lagos State

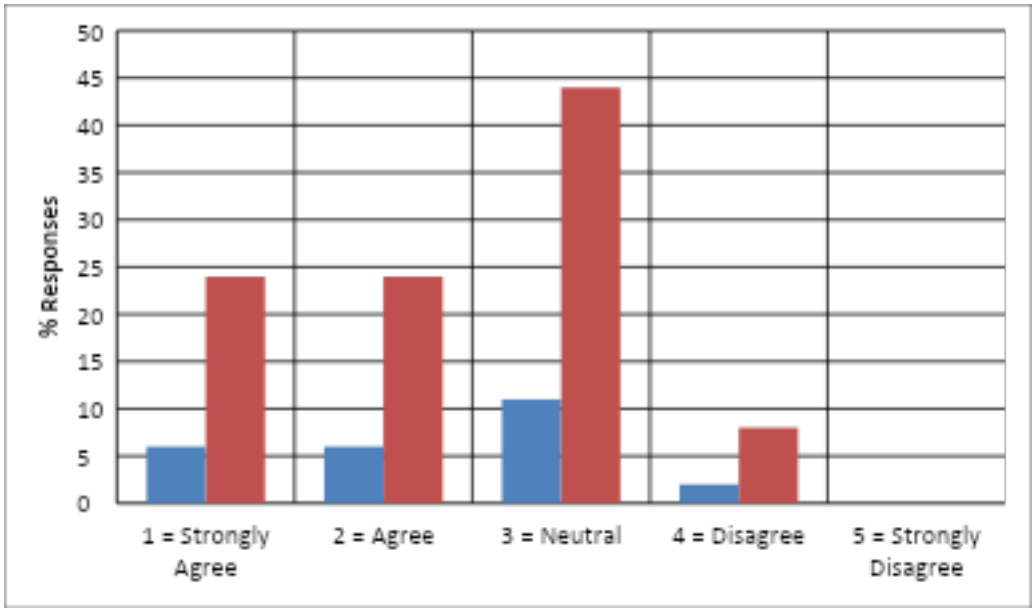


Fig. 39c: Farmer's willingness to pay for bio-fertilizer if available from MRF in Jos town, Plateau State

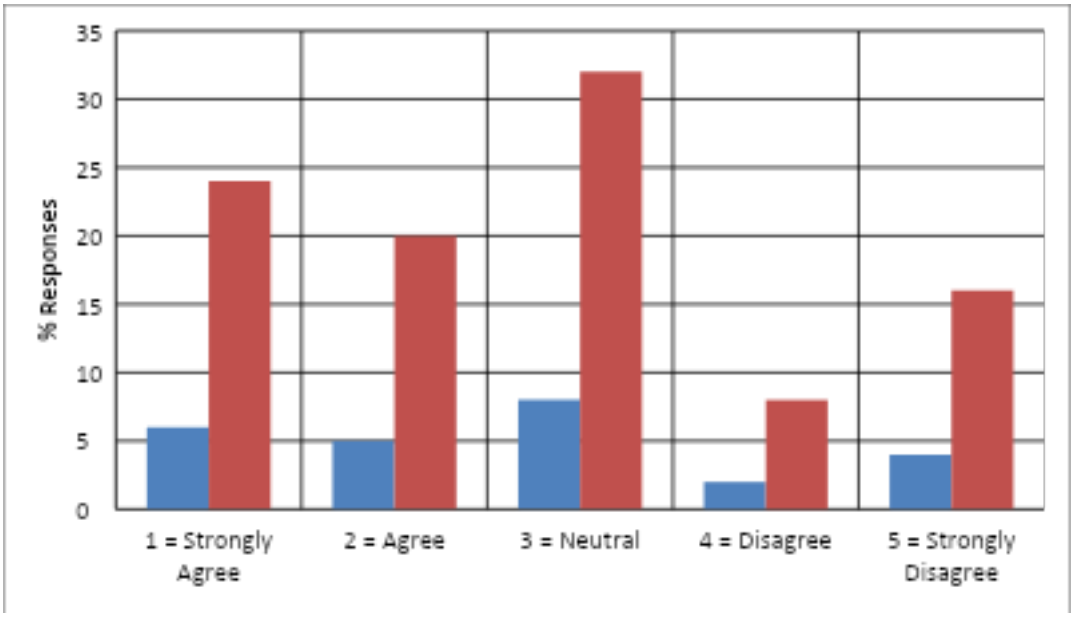


Fig. 39d: Farmer's willingness to pay for bio-fertilizer if available from MRF in the FCT, Abuja

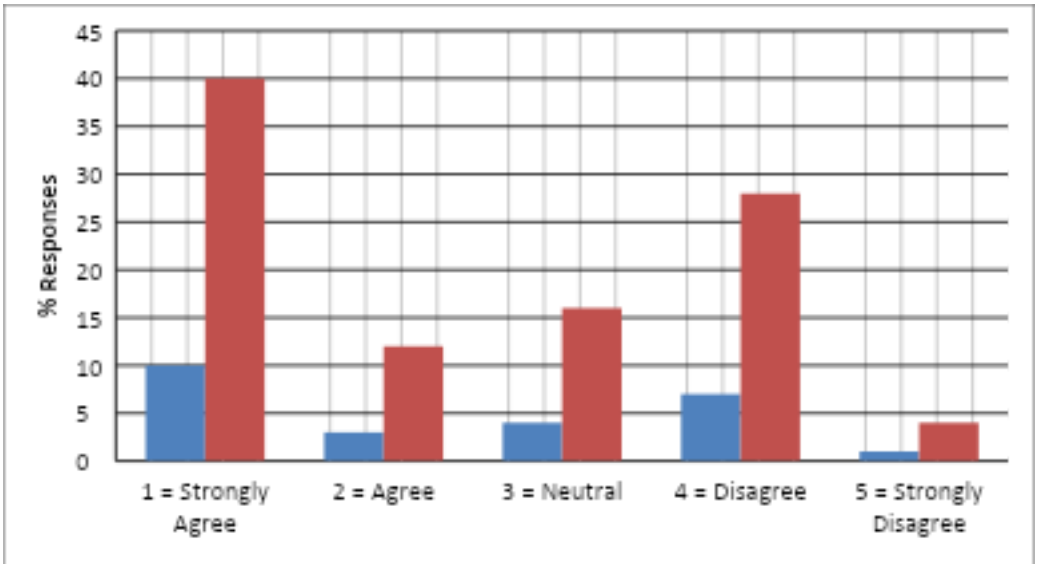


Fig. 40a: Farmer's Knowledge of environmental impacts of chemical fertilizer in Benin City, Edo State

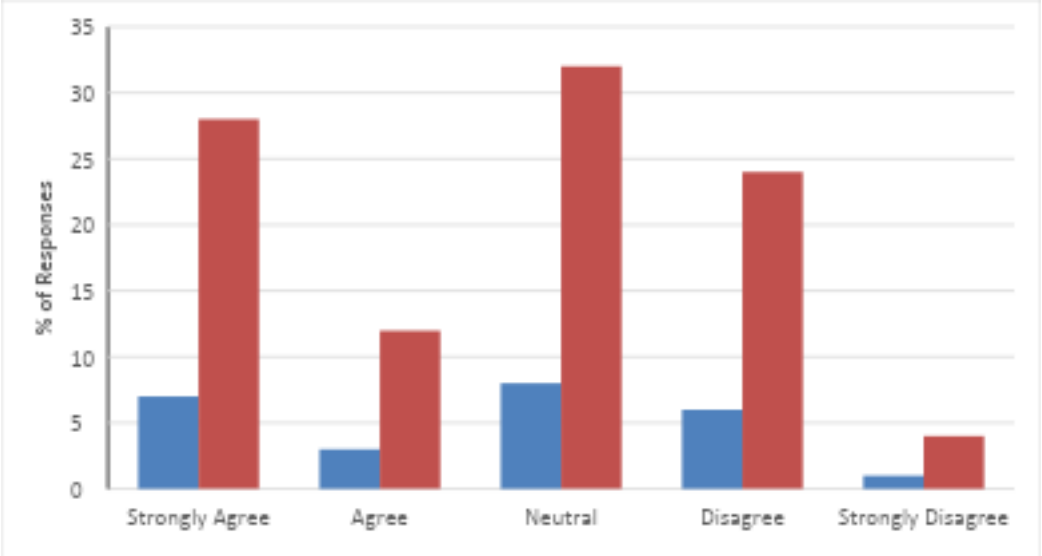


Fig. 40b: Farmer's Knowledge of environmental impacts of chemical fertilizer in Epe, Lagos State

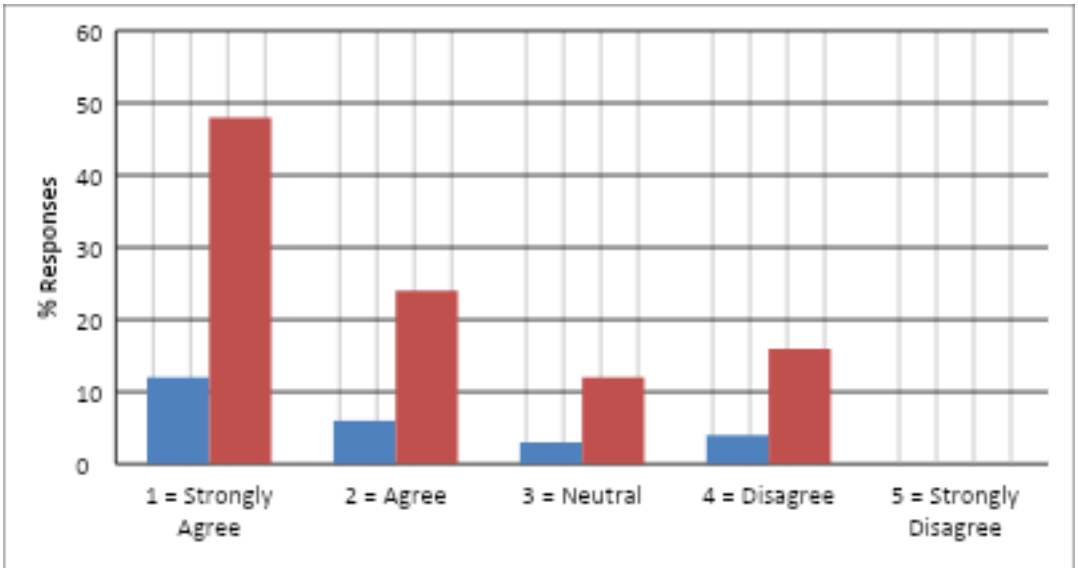


Fig. 40c: Farmer's Knowledge of environmental impacts of chemical fertilizer in Jos Town, Plateau State

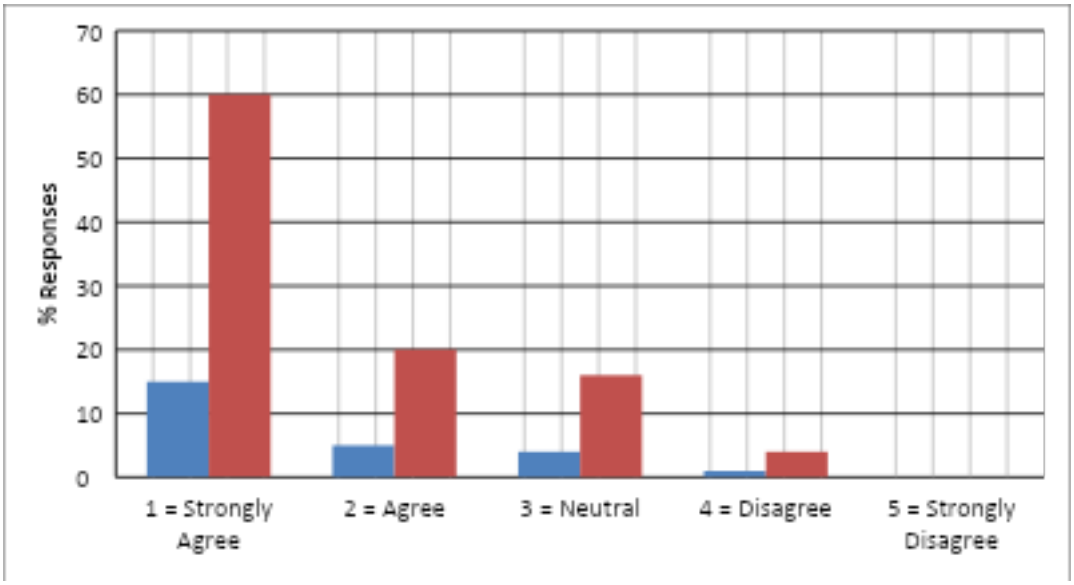


Fig. 40d: Farmer's Knowledge of environmental impacts of chemical fertilizer in the FCT, Abuja

Determinants of Organic Fertilizer use among Farmers

In Figs 40 and 41a-d the determinants of organic fertilizer use among farmers and determinants of composting initial success. In Figs 41a-d, provision of incentives and subsidization of composting facility, including free trainings and retraining on composting technicalities, more workshops and awareness creation programmes are also key determinants of wide application of bio-fertilizer in Nigeria. Such trainings should target increasing farmer's roles and participation

in both proposed Multi-solving action for Methane Reduction in Nigeria (MAMRN), project and advocacy for Zero Waste initiative of the State government. In Figs. 42 a-d, farmers expressed optimism that training on composting process, packaging and incentives to facilitate the purchase of composting facility are key to initial success of complete switch to composting manure. In Figs 43a-d farmers also iindicated that switching to organic waste holds many benefits, including the ability to improve the quality of soil as well as being cost effective. Furthermore, sampled farmers indicated that MAMRN project is a very good idea and are also enthusiastic that implementing the Multi-Solving Action for Methane Reduction in Nigeria (MAMRN) and siting of a Material Recovery Facility in their localities, will create employment opportunities, increase household income level through waste-wealth and also result in general community development (44a-d).

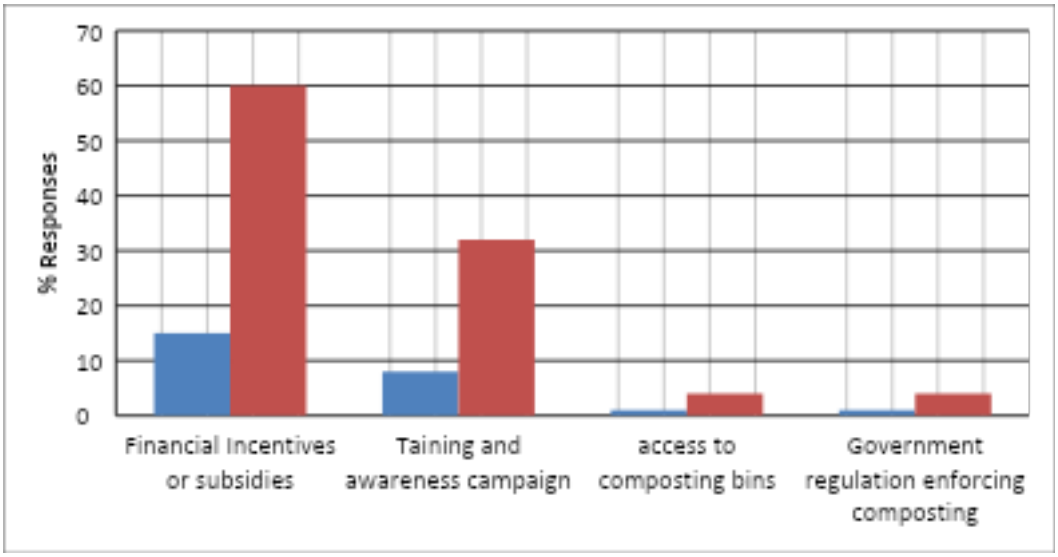


Fig. 41a: Determinants of organic fertilizer use among farmers in Benn City, Edo State

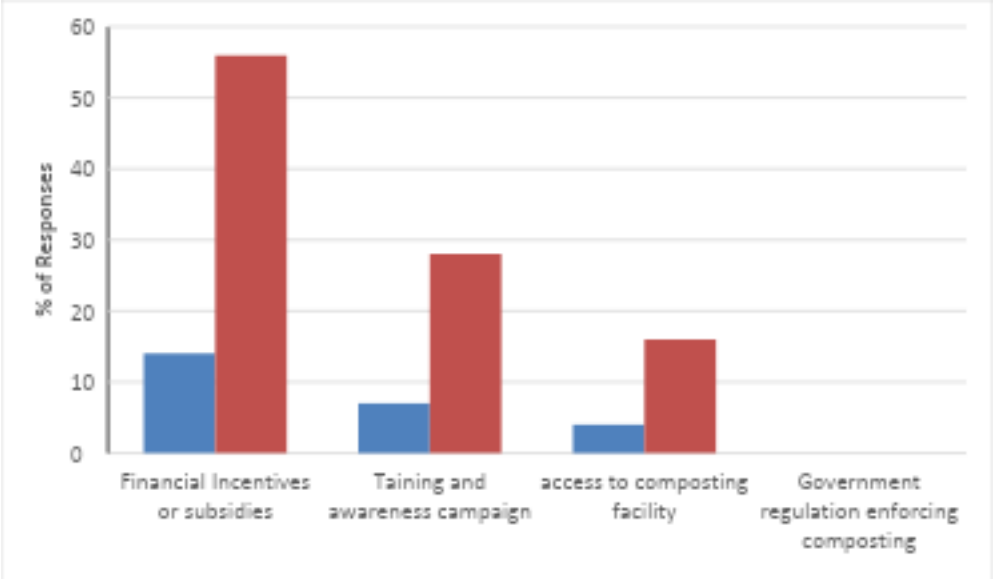


Fig. 41b: Determinants of organic fertilizer use among farmers in Epe, Lagos State

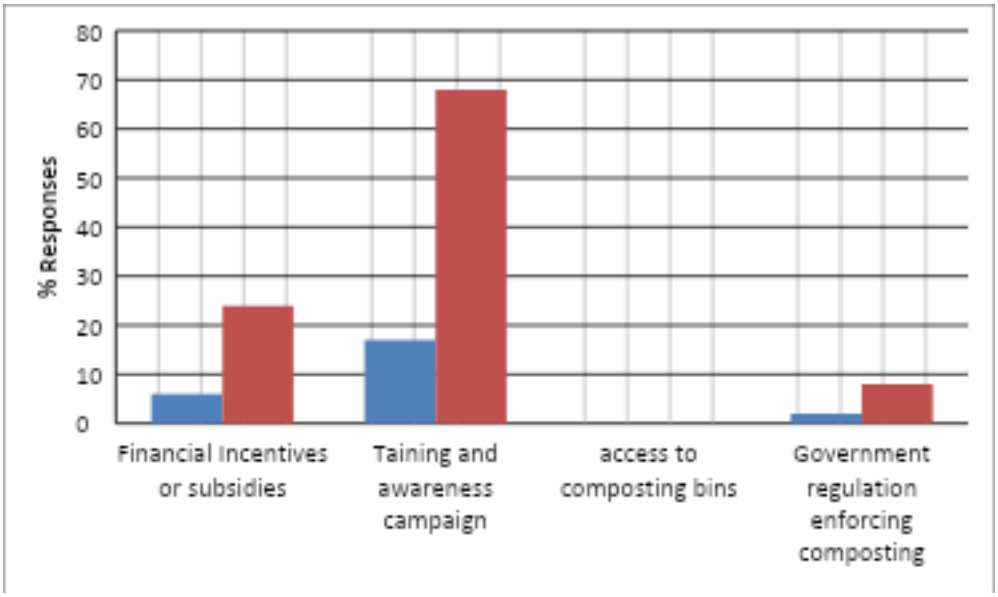


Fig. 41c: Determinants of organic fertilizer use among farmers in Jos Town, Plateau State

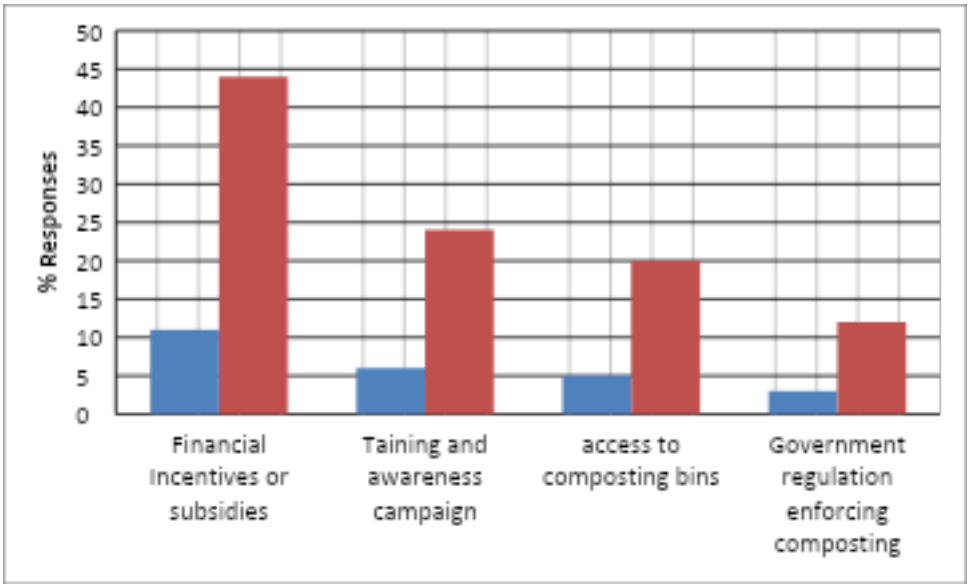


Fig. 41d: Determinants of organic fertilizer use among farmers in the FCT, Abuja

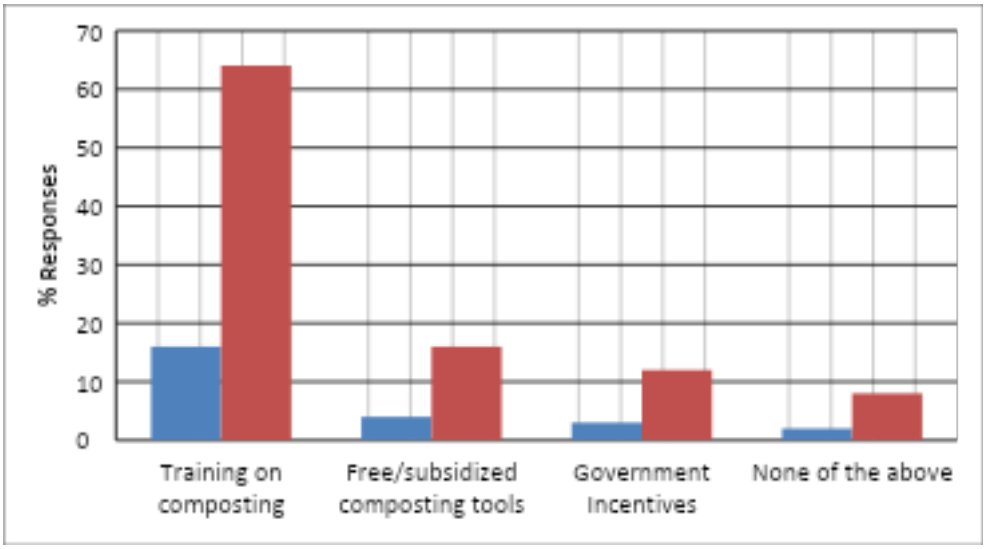


Fig. 42a: Determinants of composting initial success in Benin City, Edo State

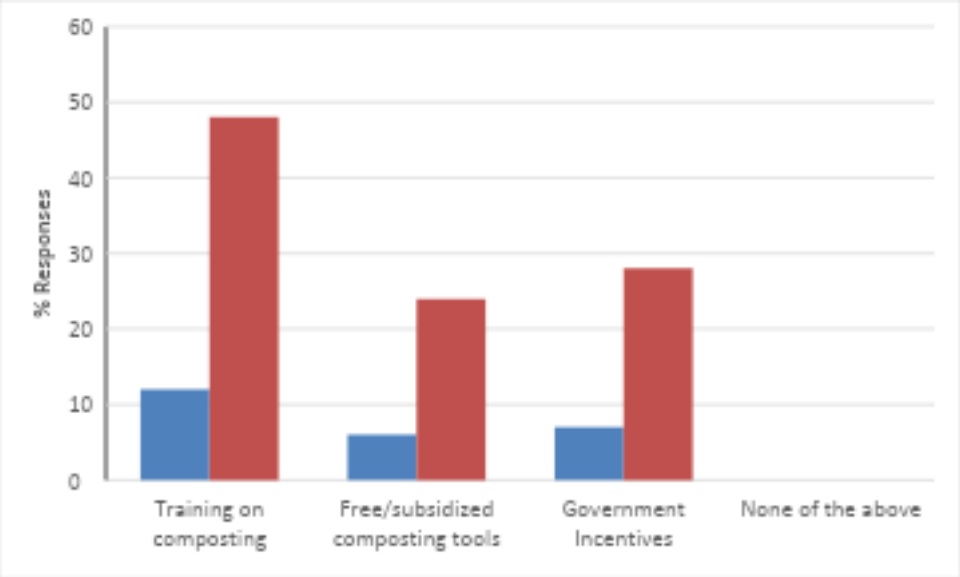


Fig. 42b: Determinants of composting initial success in Epe, Lagos State

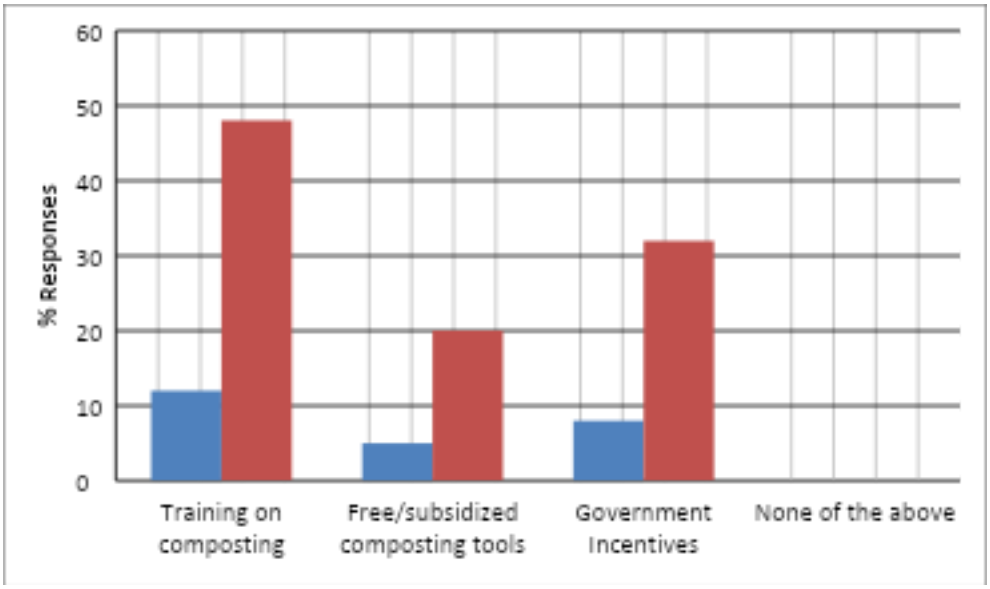


Fig. 42c: Determinants of composting initial success in Jos town, Plateau State

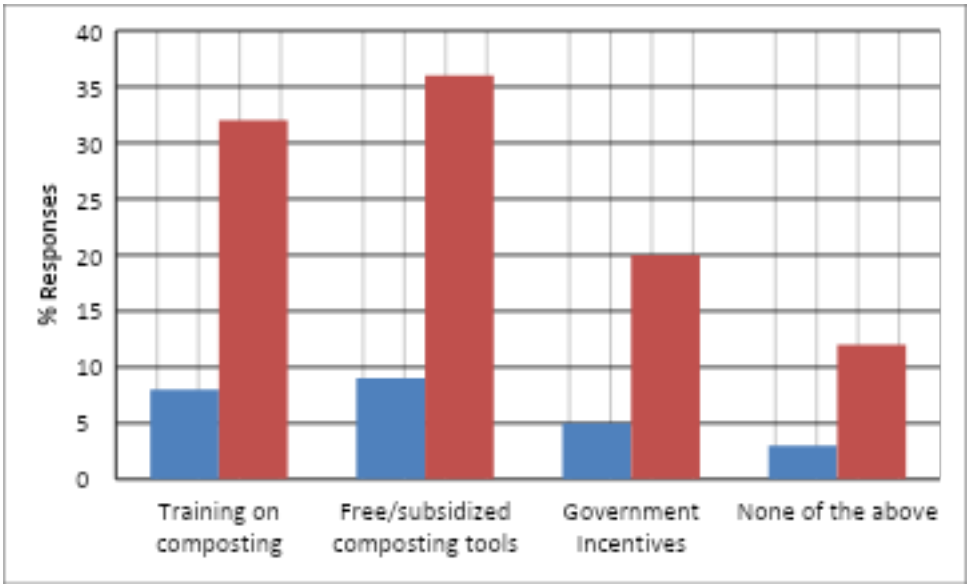


Fig. 42d: Determinants of composting initial success in the FCT, Abuja

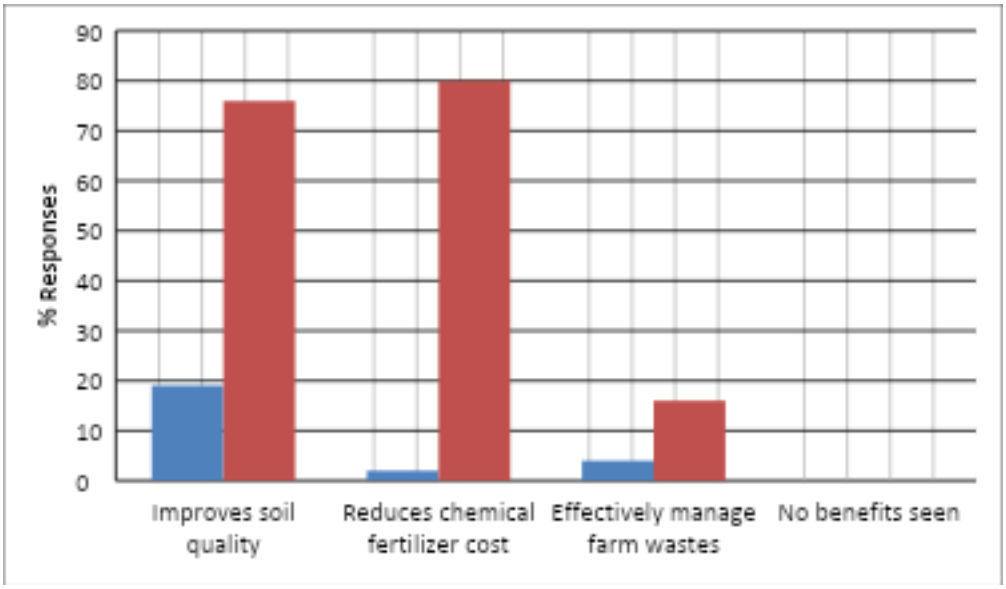


Fig. 43a: Farmer's Views on the environmental benefits of using organic fertilizer in Benin City, Edo State

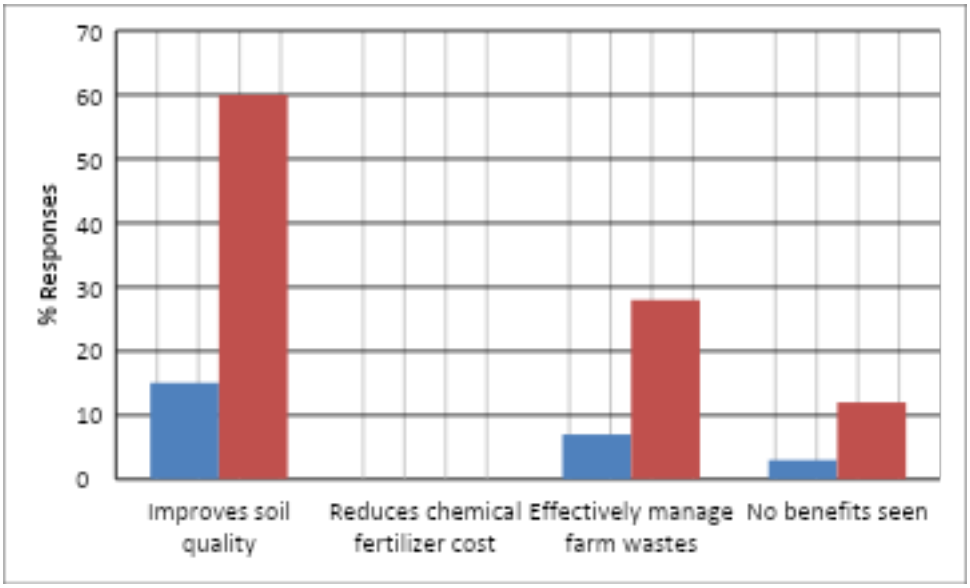


Fig. 43b: Farmer's Views on the environmental benefits of using organic fertilizer in Epe, Lagos State

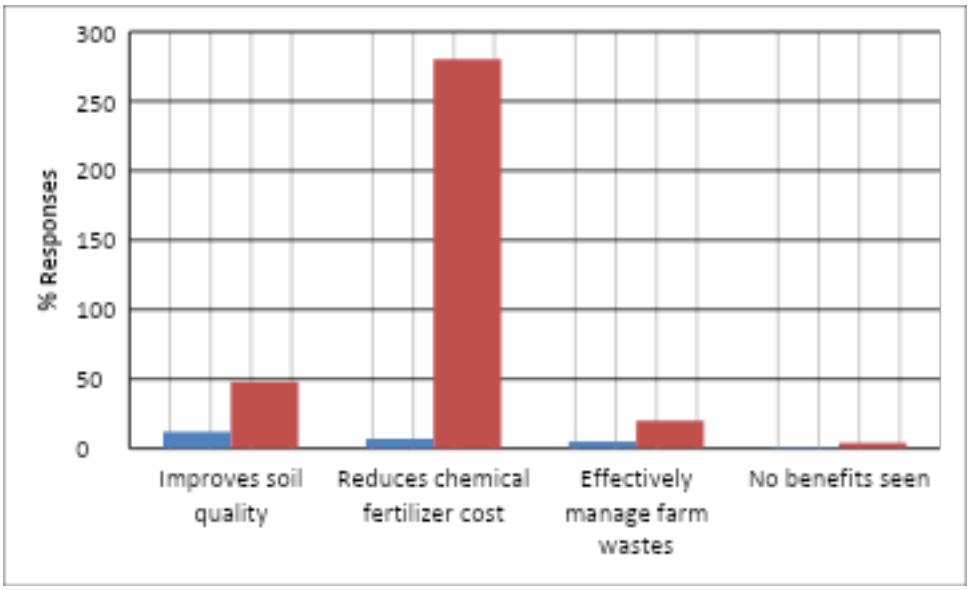


Fig. 43c: Farmer's Views on the environmental benefits of using organic fertilizer in Jos Town, Plateau State

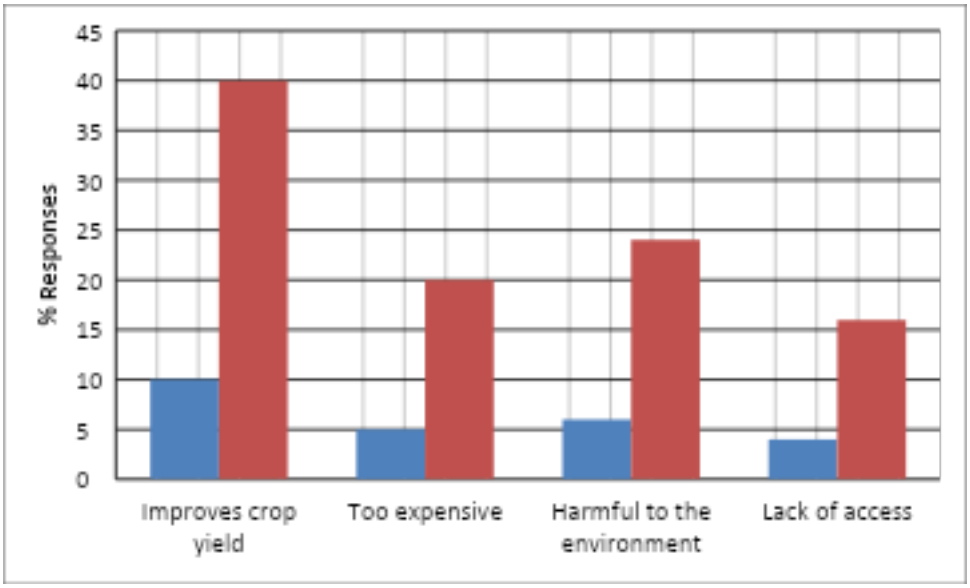


Fig. 43d: Farmer's Views on the environmental benefits of using organic fertilizer in the FCT, Abuja

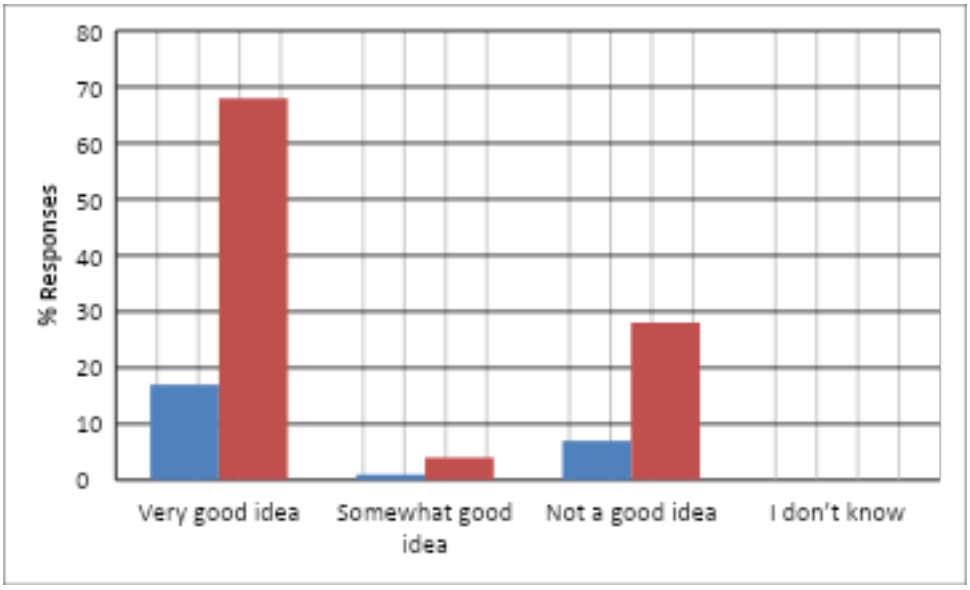


Fig. 44a: Farmer's view of the potential impacts of MAMRN project in Benin City, Edo State

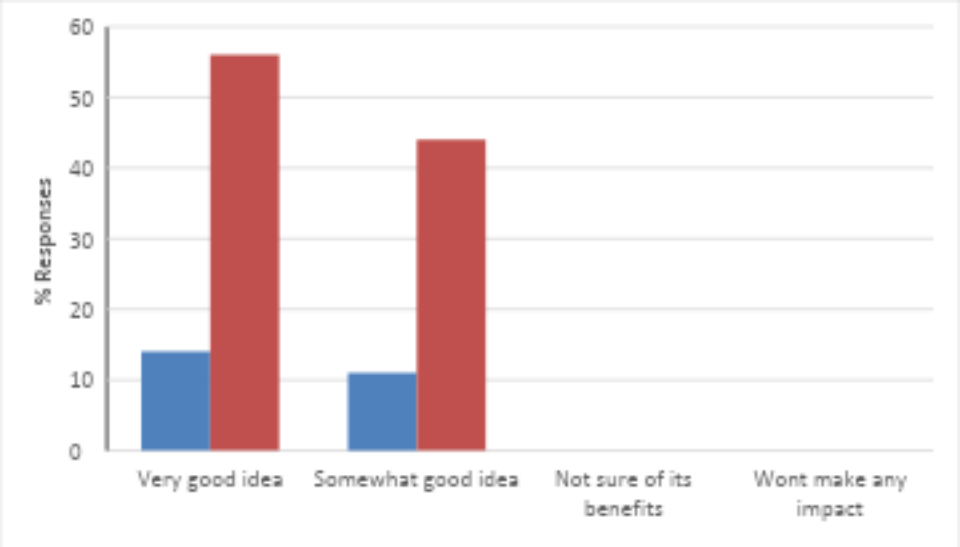


Fig. 44b: Farmer's view of the potential impacts of MAMRN project in Epe, Lagos State

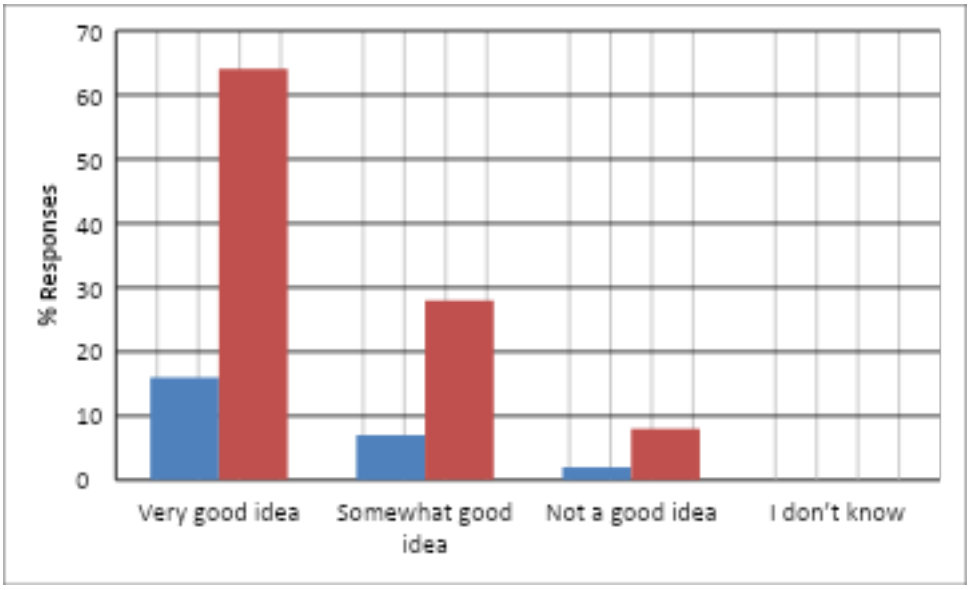


Fig. 44c: Farmer's view of the potential impacts of MAMRN project in Jos Town, Plateau State

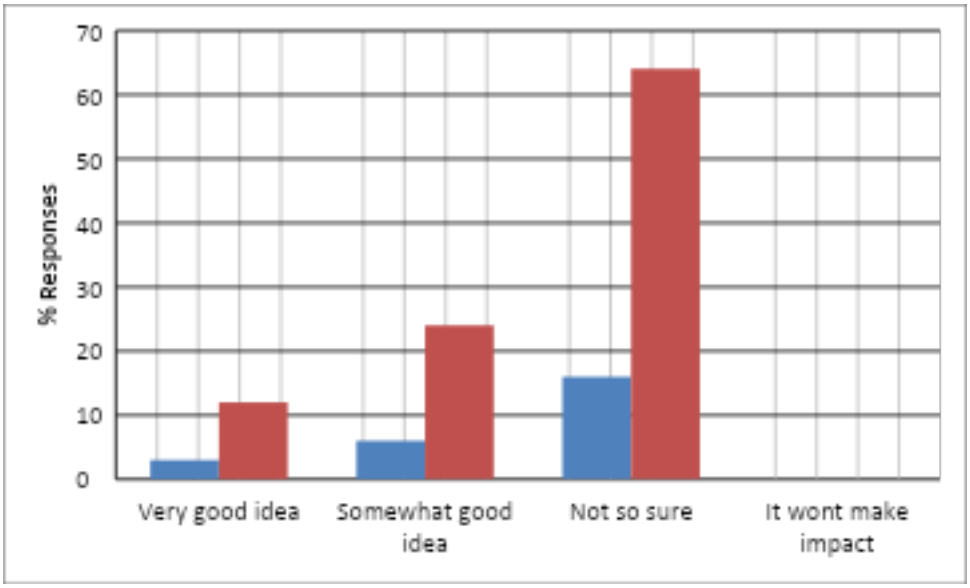


Fig. 44d: Farmer's view of the potential impacts of MAMRN project in the FCT, Abuja

11.6. Baseline Results: Views And Perceptions of Sampled Households About MSW and Material Recovery Across Nigeria

Common Household Waste Types and management

In Fig. 45a-d, decomposable waste such as fruits and vegetables including rinds, peels, cores, and uneaten portions of fruits and vegetables, bones, scraps, and offal from meat, poultry, and fish preparation, eggshells are predominant waste types generated at homes. Plastic waste and other forms of waste are not very common because of their reuse potentials and more so plastics and metals/tins are sold directly to waste pickers, while cartons and woods are use as fuels. Figs 46a-d, show that most of the waste generated by household in Benin City and Jos Town disposed of in any available open space, while in Epe, Lagos residents commonly dispose of their waste in nearby government provided bins or designated points (sometimes black spots or open space) for collection by LAWMA. In the FCT, Abuja, private waste vendor usually collect household waste for disposal. Another prominent method employed by residents in the disposal of their waste is burning of non-decomposable waste component, especially during dry season. Most of sampled residents do not compost their organic waste due to poor awareness and education in that regards and lack of access to the facility. In Figs 47a-d, inadequate waste collection service, insufficient public waste bins and the fact that most residents lack composting facility are major problems of waste management. Some of the challenges of composting at Household were the lack of

knowledge on the processes involved in composting, followed by the complain of not having access to composting facility. Some households also indicated that there is not framework for source sorting, hence all waste types are dumped together ar approved and unapproved dumpsites (48a-d). In a similar study Ishola, and Ishola (2019) also argued that the lack of awareness and inadequate information on compost was a major barrier to Composting and Sustainable Development in developing countries. To enhance a wider spread of organic waste management approach in Epe community, and also promote Household participation in the proposed material recovery initiative, an adequate educational knowledge is key in a participative manner in order to better understand and increase the use of compost. Composting can offer an endless possibility in organic waste management; however, this depends on the level of knowledge and people's willingness to participate in the recovery model. Apart from creating awareness and public sensitization on composting, household income level and supports from government are other key determinants of the composting initiative in Nigeria. Composting requires bins, space (trench) composting bars or piles.

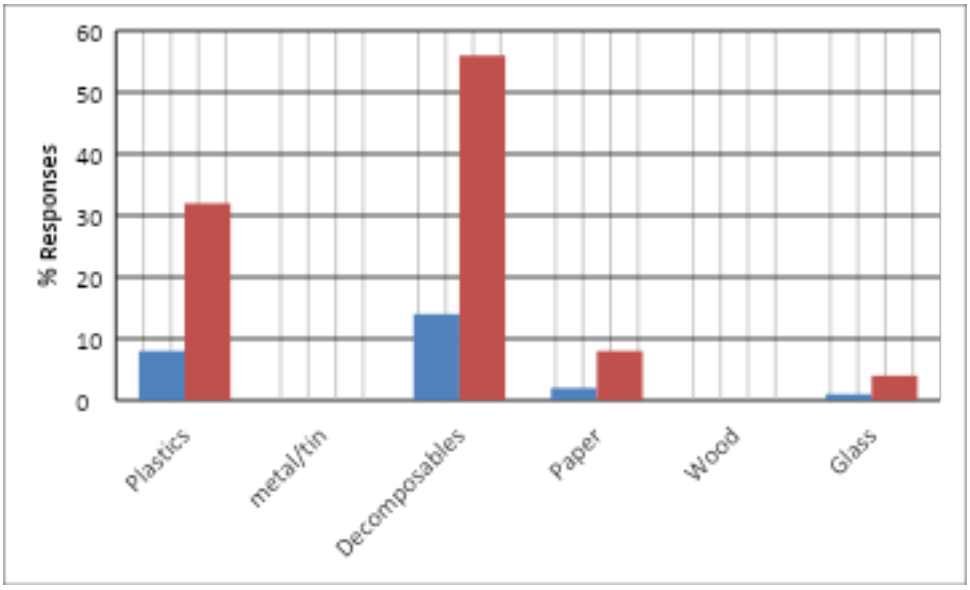


Fig. 45a: Common Household waste types at sampled dumpsites in Benin City, Edo State Nigeria

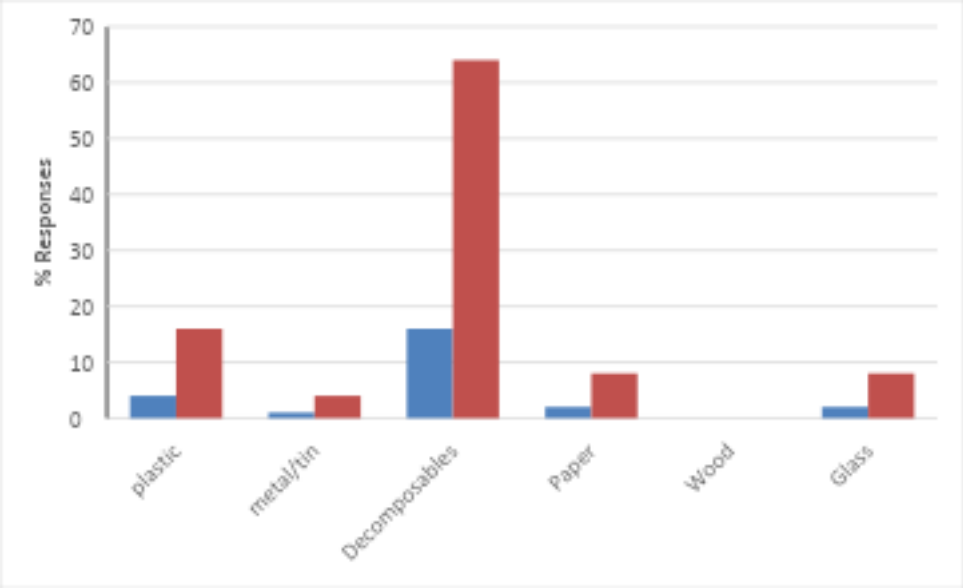


Fig. 45b: Common Household waste types at sampled dumpsites in Epe, Lagos State

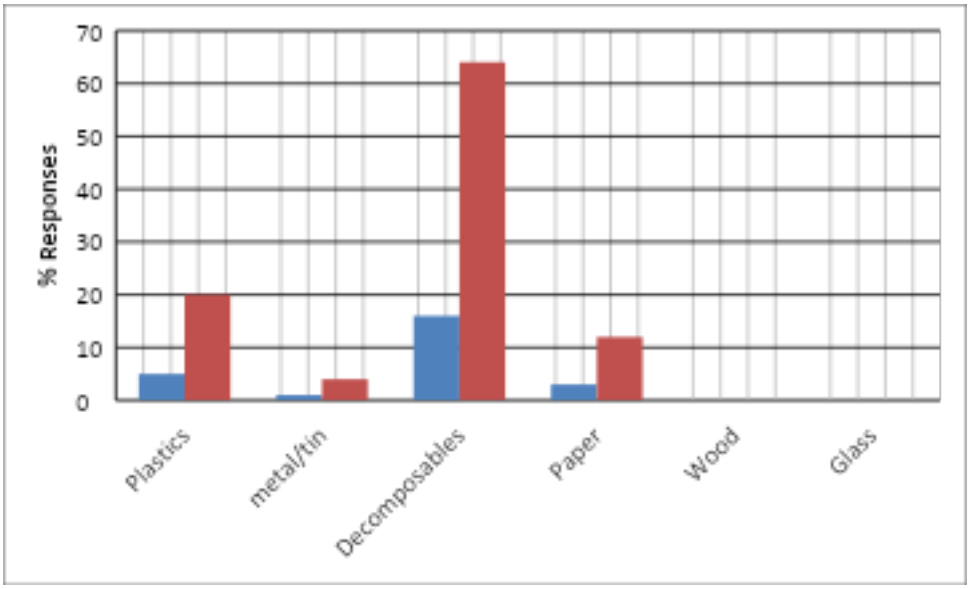


Fig. 45c: Common Household waste types at sampled dumpsites in Jos town, Plateau State

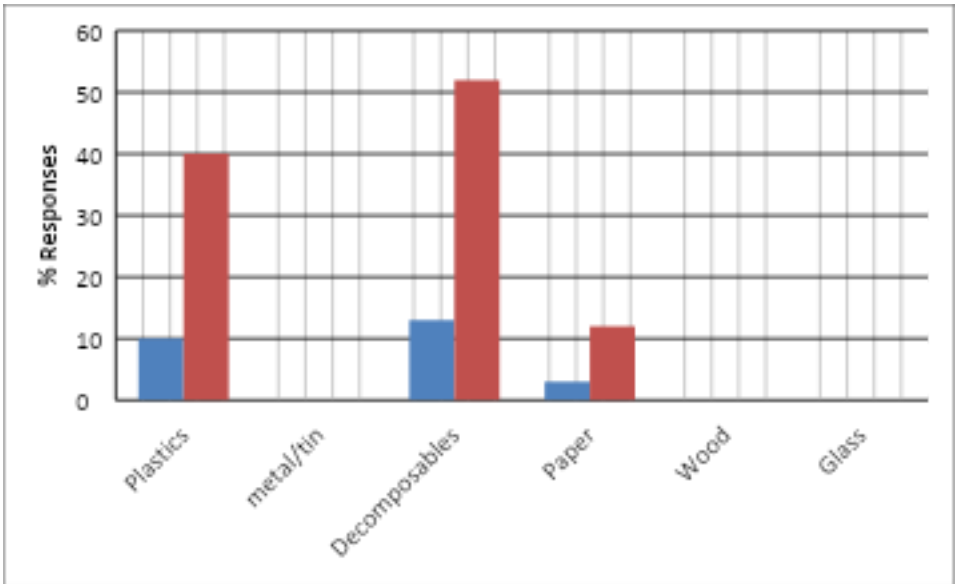


Fig. 45d: Common Household waste types at sampled dumpsites in the FCT, Abuja

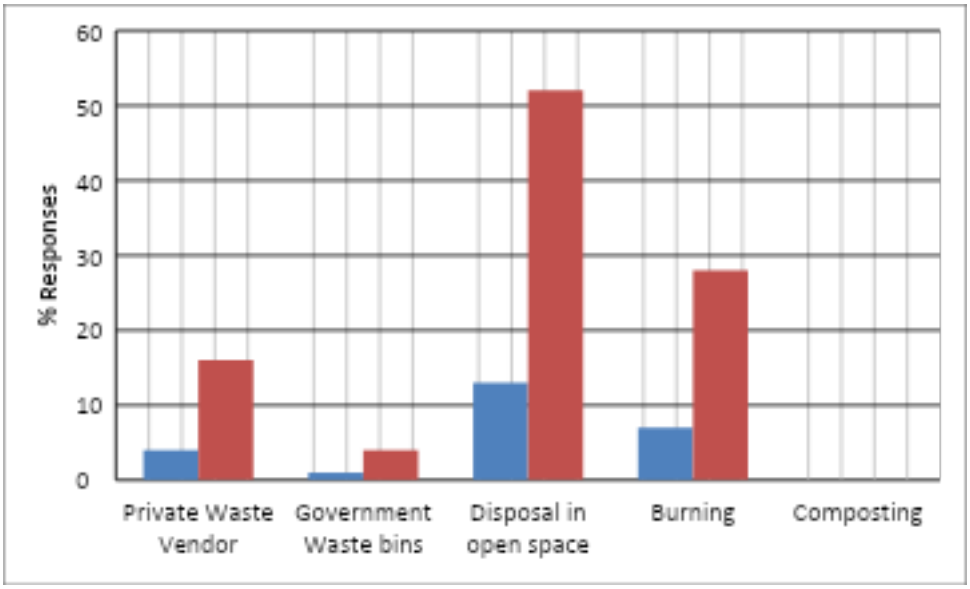


Fig. 46a: Waste disposal practice/Handling by Households in Benin City, Edo State

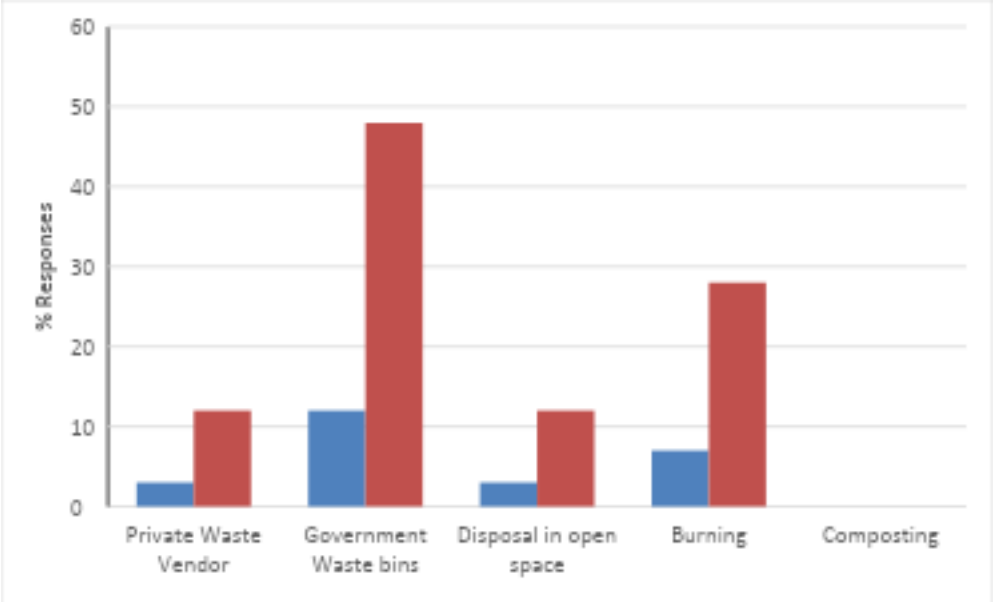


Fig. 46b: Waste disposal practice/Handling by Households in Epe, Lagos State

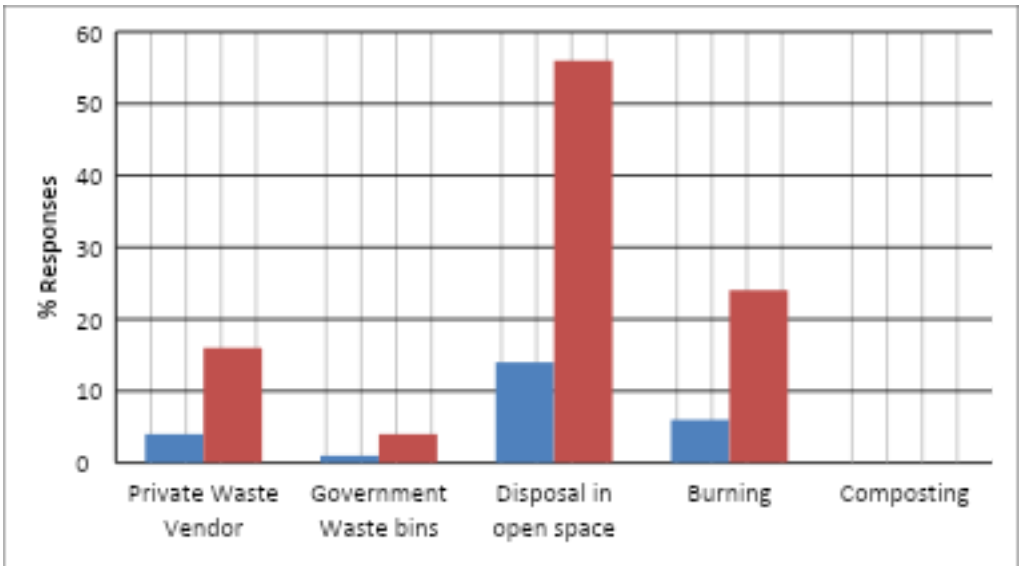


Fig. 46c: Waste disposal practice/Handling by Households in Jos Town, Plateau State

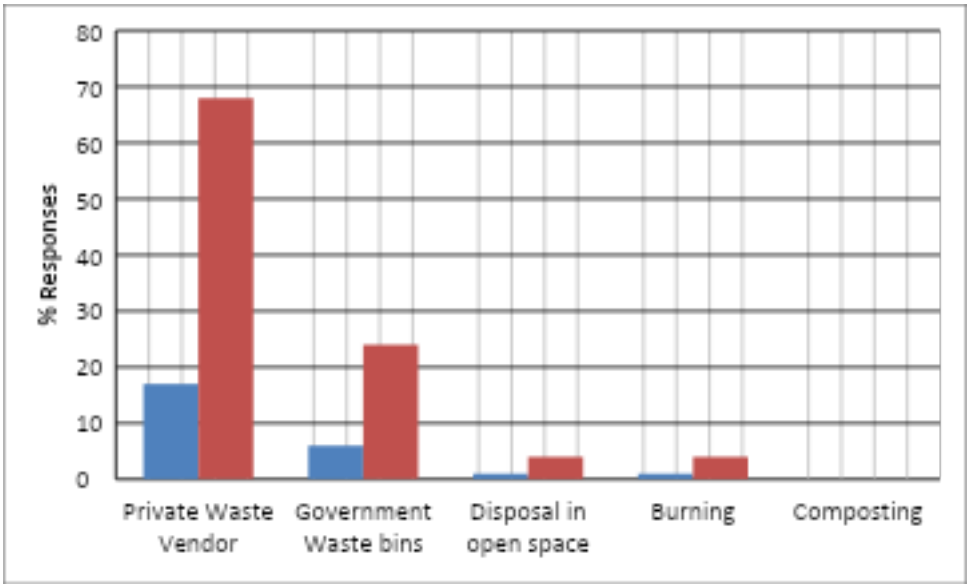


Fig. 46d: Waste disposal practice/Handling by Households in the FCT, Abuja

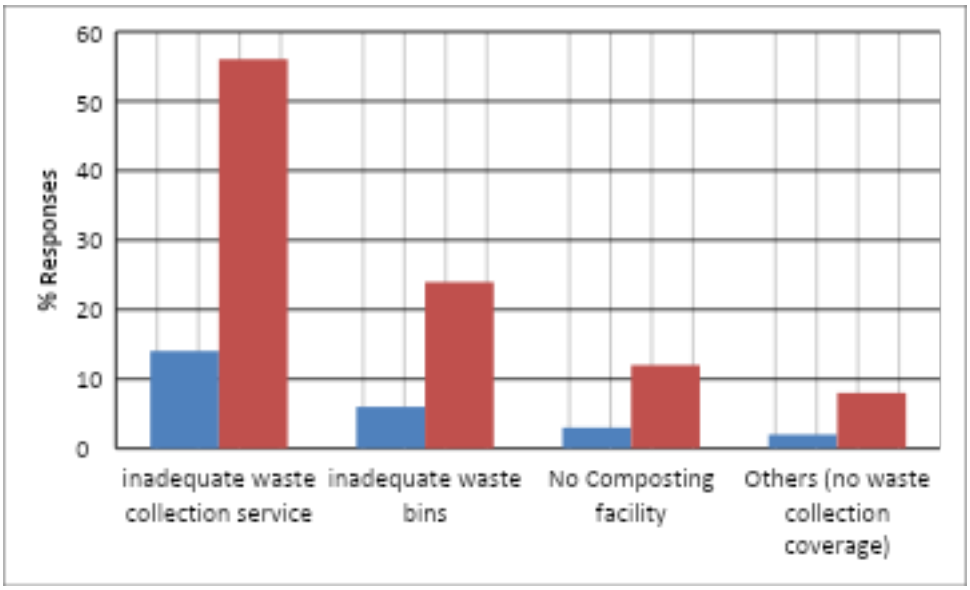


Fig. 47a: Observable waste management problems in Benin City, Edo State: Response from sampled Households

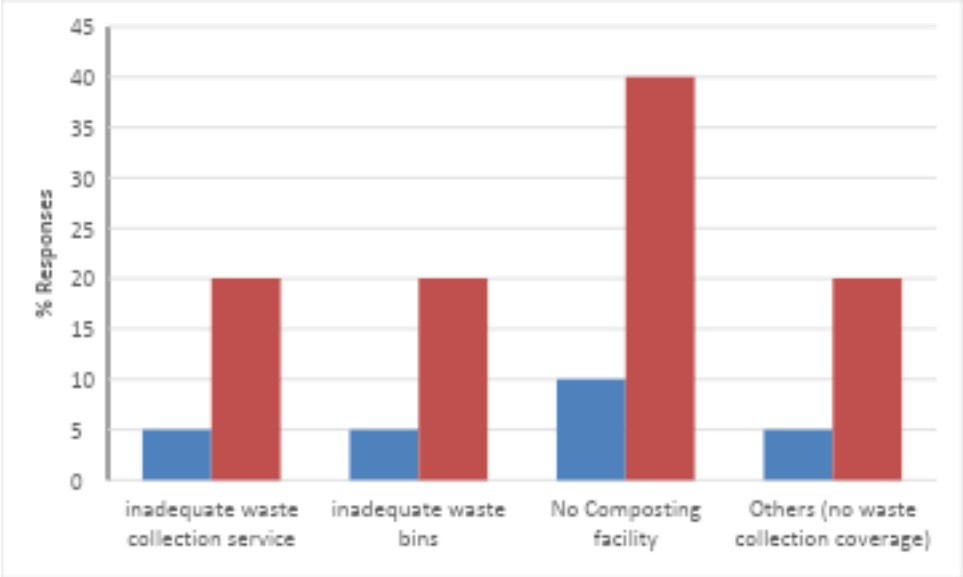


Fig. 47b: Observable waste management problems in Epe, Lagos State: Response from sampled Households

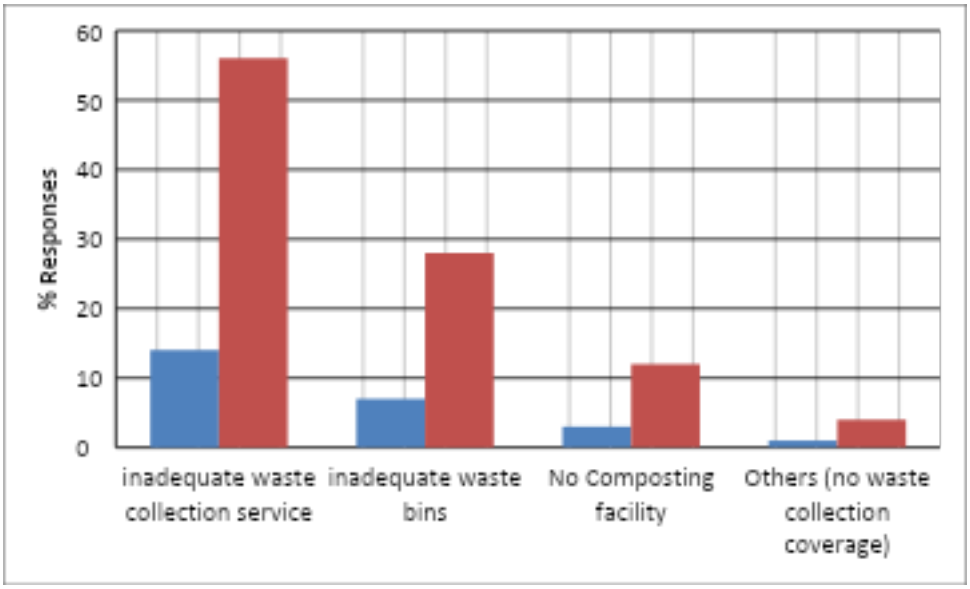


Fig. 47c: Observable waste management problems in Jos Town, Plateau State: Response from sampled Households

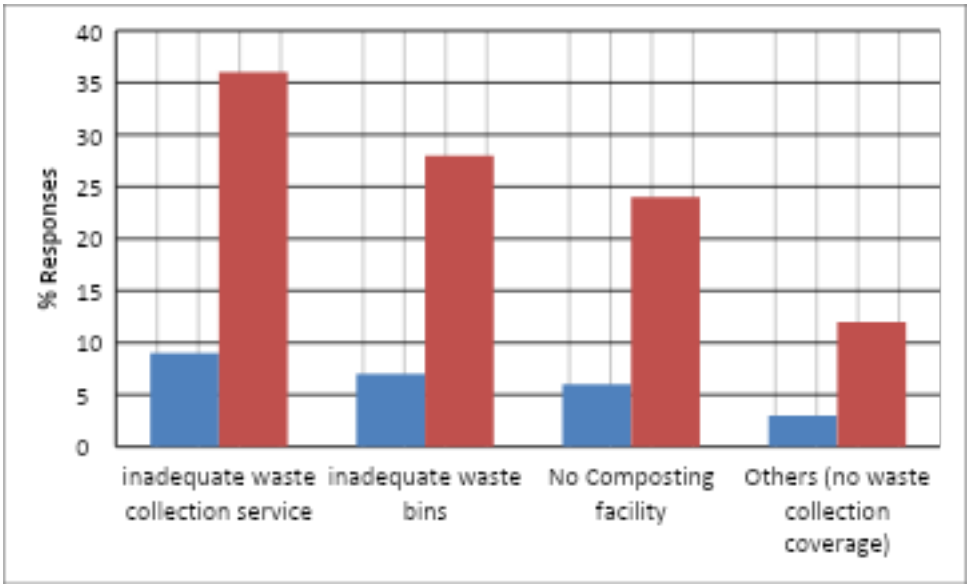


Fig. 47d: Observable waste management problems in the FCT, Abuja: Response from sampled Households

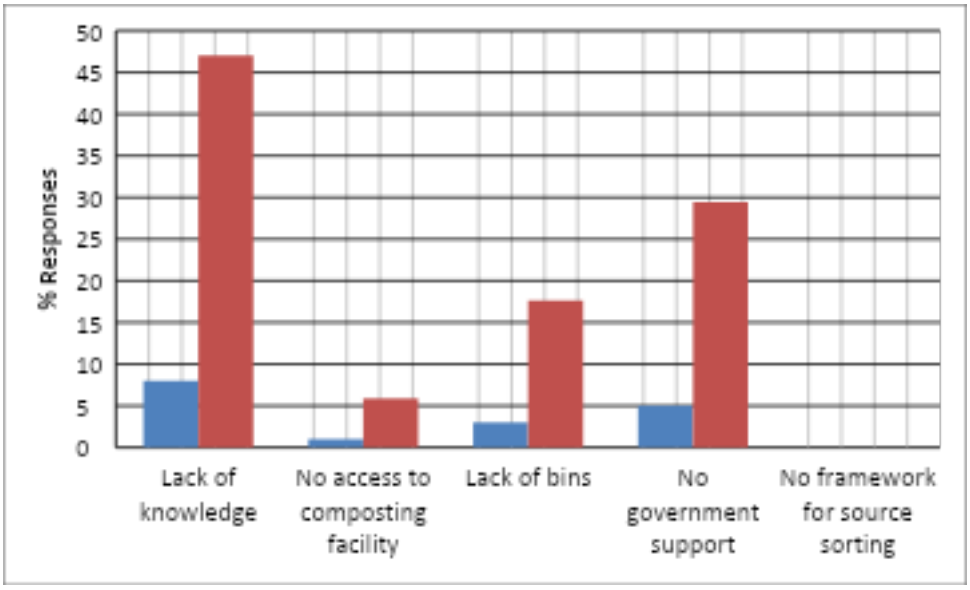


Fig. 48a: Challenges of composting at Household in Benin City, Edo State

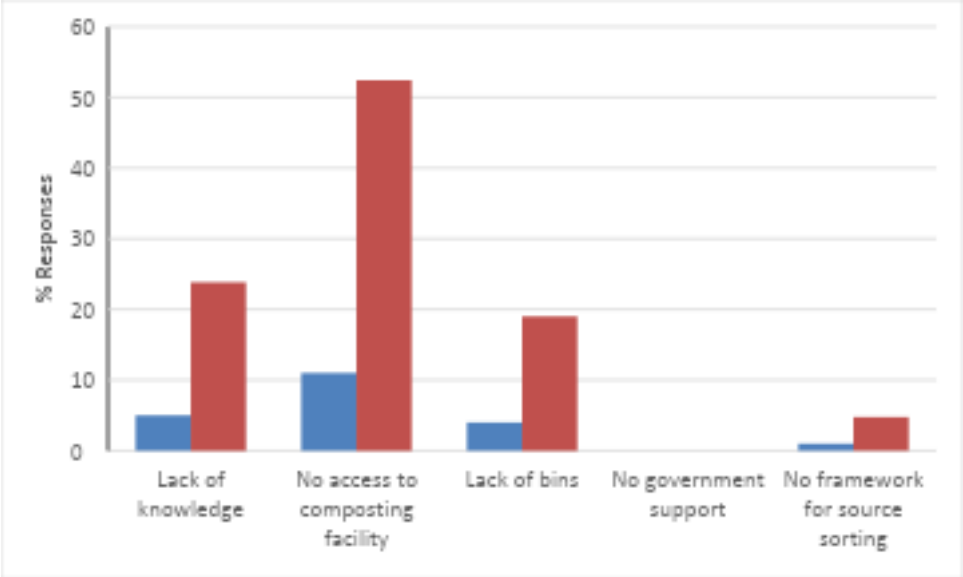


Fig. 48b: Challenges of composting at Household in Epe, Lagos State

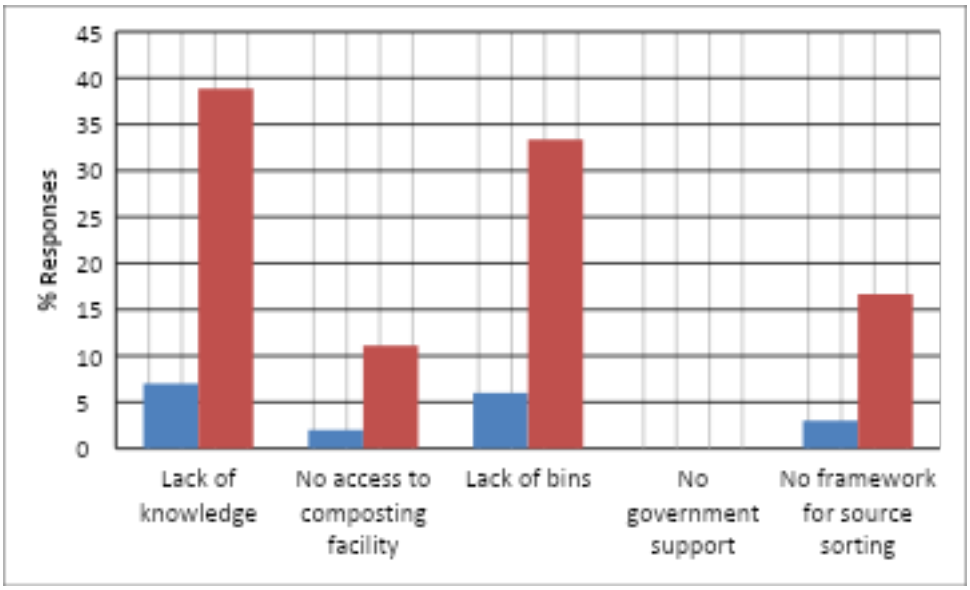


Fig. 48c: Challenges of composting at Household in Jos town, Plateau State

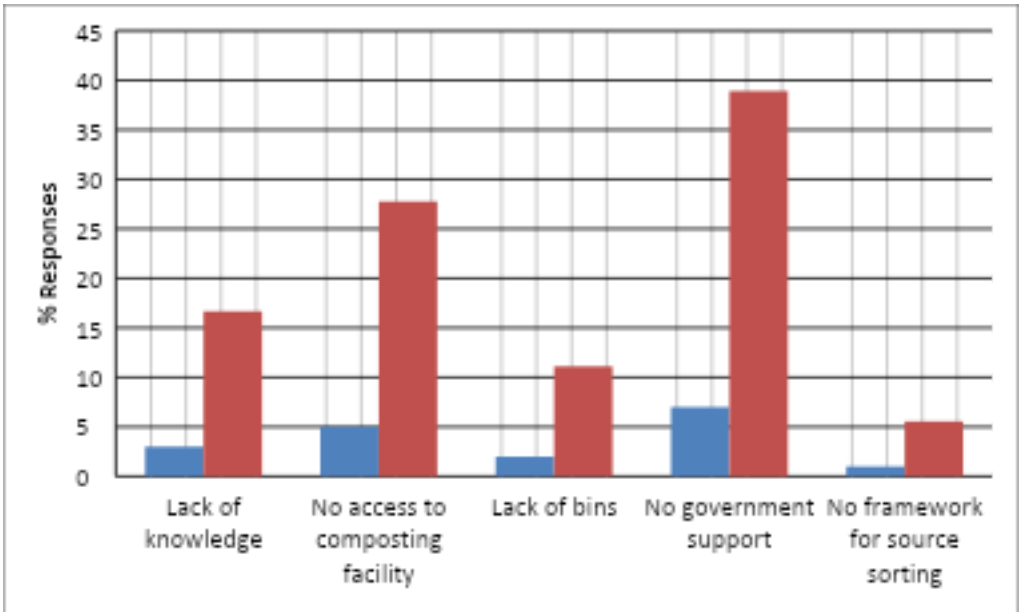


Fig. 48d: Challenges of composting at Household in the FCT, Abuja

Perceived determinants of Composting success at Household level

Households across the surveyed states and the FCT, Abuja are optimistic that with sponsored trainings and income levels of household and educational level can influence community's participation in material recovery process (Figs. 49 a-d). Methane and CO_2 emission from organic waste and open burning of waste are important source of GHGs. To effectively address methane and CO_2 emission, the community's attitude towards waste must change, and hence the need to access the community's perception of climate changes. In Figs 50a-d, household's knowledge of climate change is presented, while in Figs 51a-d, community perceived indicators of climate change is presented. In Fig 50, there is high level of awareness of on-going climate change and in Fig. 51 majority of the respondents in Benin City indicated that flooding and erosion are some of the indicators of climate change. In Epe, Lagos, respondents reported that increased air-borne diseases and increase temperature/heat are some of the indicators. In Jos town, respondents indicated that atmospheric temperature is changing as residents experience high air temperature. In the FCT, Abuja, respondents reported that increased air-borne diseases and increase temperature/heat are some of the indicators of climate change. As a result of these effects the community's willingness to participate in methane reduction process was assessed Figs. 52a-d. In Benin City, majority of households are willing to be part of the process but are

not willing to pay for training, except it is provided at no cost to them by stakeholders. Another 20% indicated that they are willing to pay depending on the cost of the training. In Epe, Lagos State, household indicated interest to pay for training on composting and any other sustainable MSW management initiatives, however, this will depend on the cost of such training. In Jos Town, residents showed greater willingness to pay for any form of training, depending on the cost involved (48%). However, in the FCT, Abuja about 56% of the respondents are willing to sponsor themselves for any form of training on methane reduction, while another 32% are also willing to participate in methane reduction initiative depending on the cost involved.

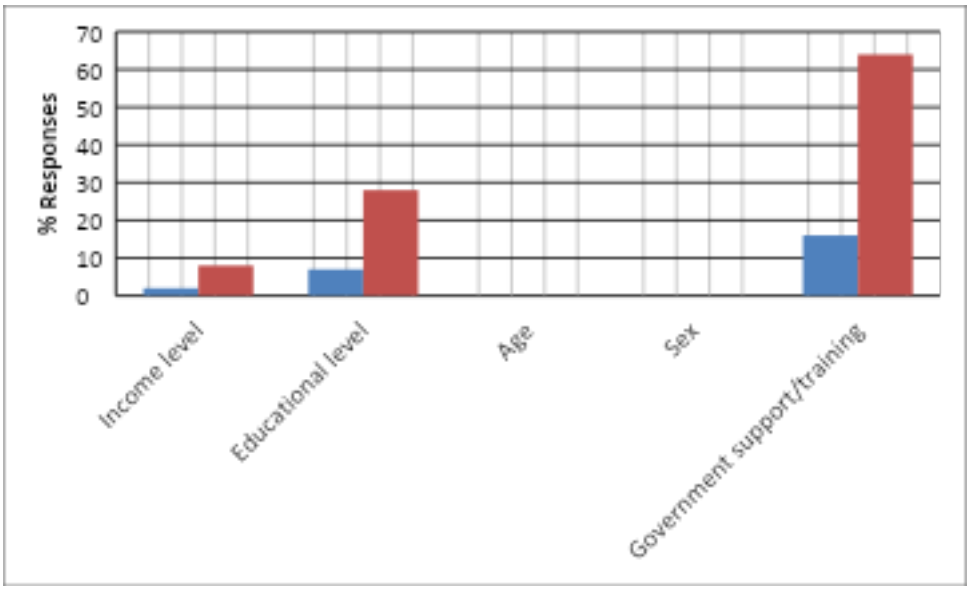


Fig. 49a: Determinants of composting success at Household level in Benin City, Edo State

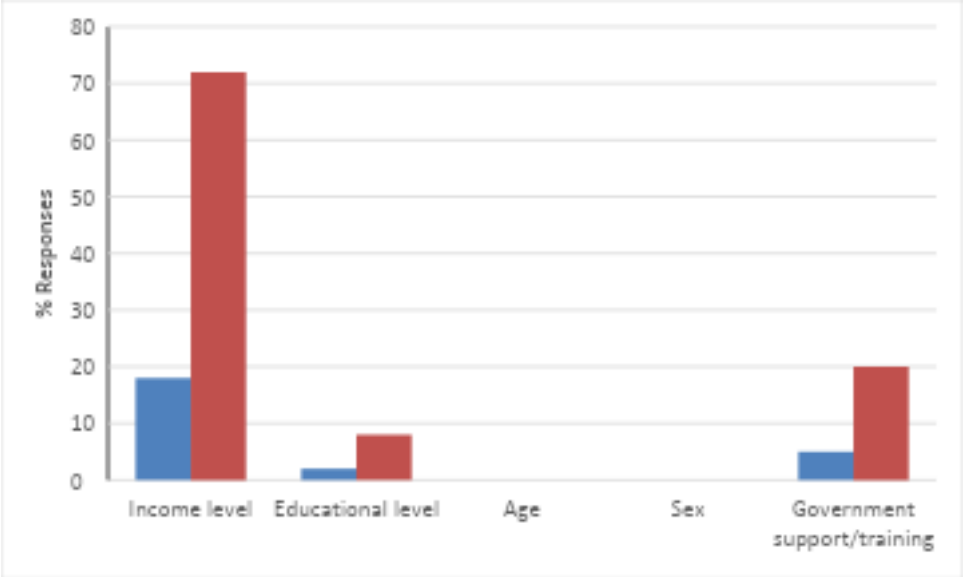


Fig. 49b: Determinants of composting success at Household level in Epe, Lagos State

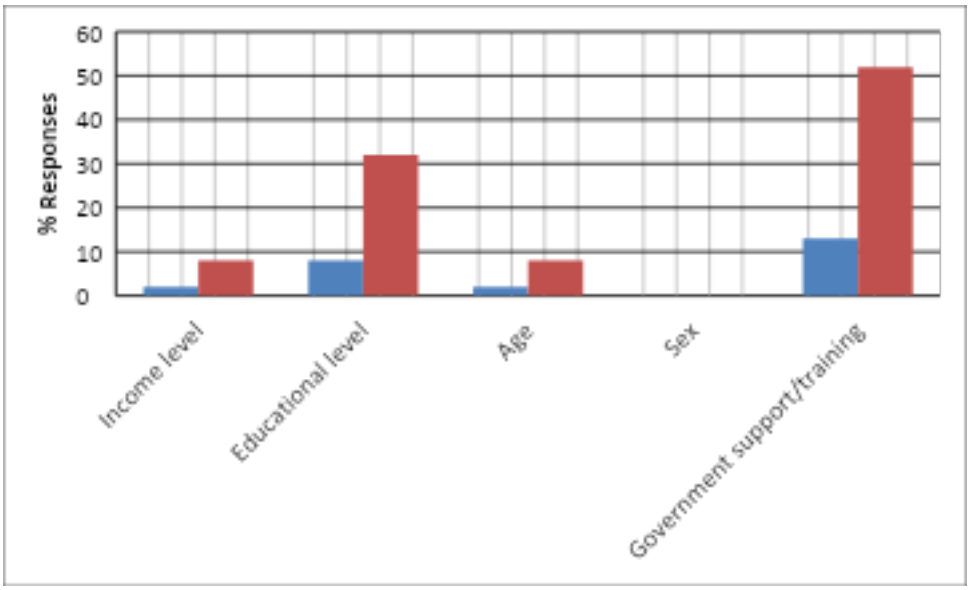


Fig. 49c: Determinants of composting success at Household level in Jos Town, Plateau State

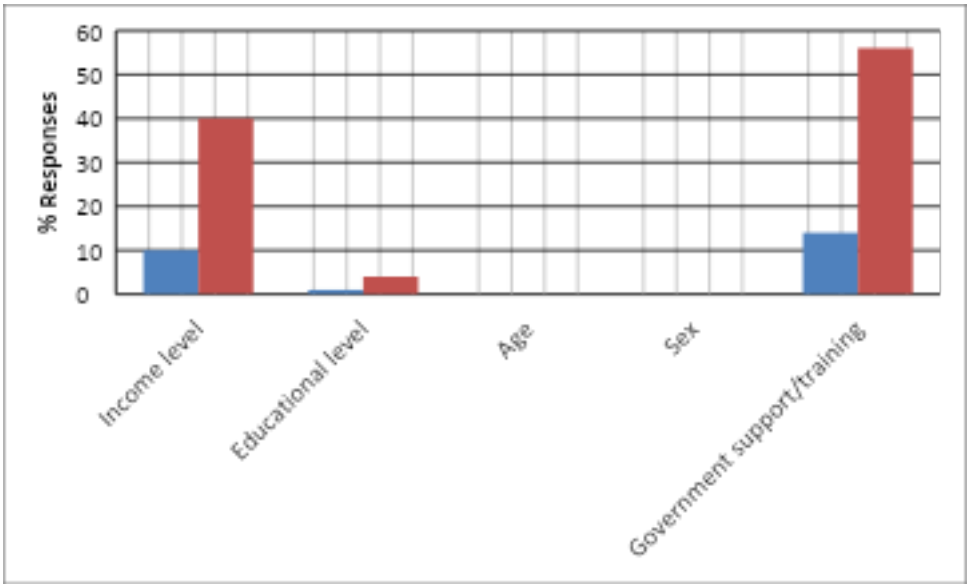


Fig. 49d: Determinants of composting success at Household level in the FCT, Abuja

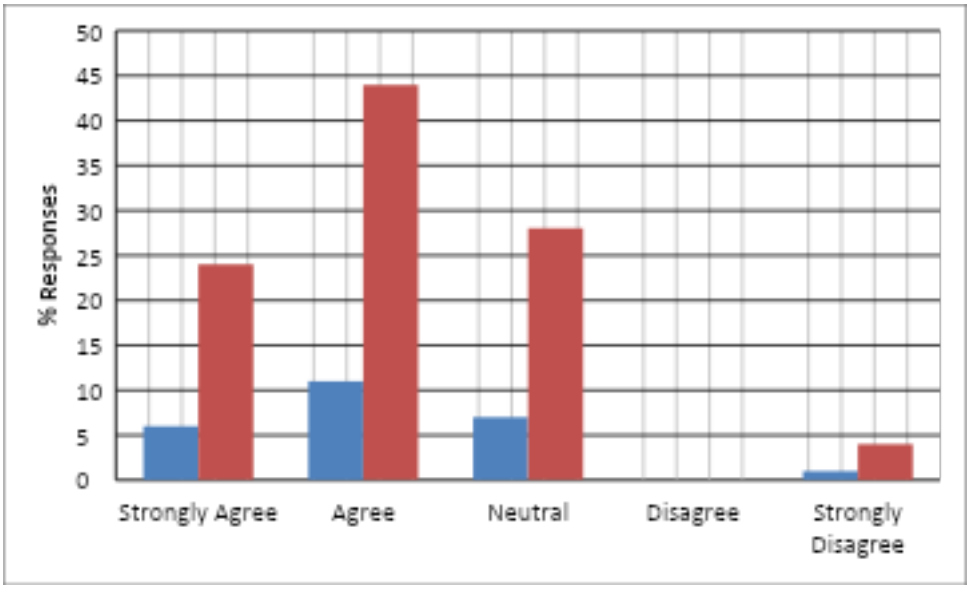


Fig. 50a: Household's knowledge of changing climate in Benin City, Edo State

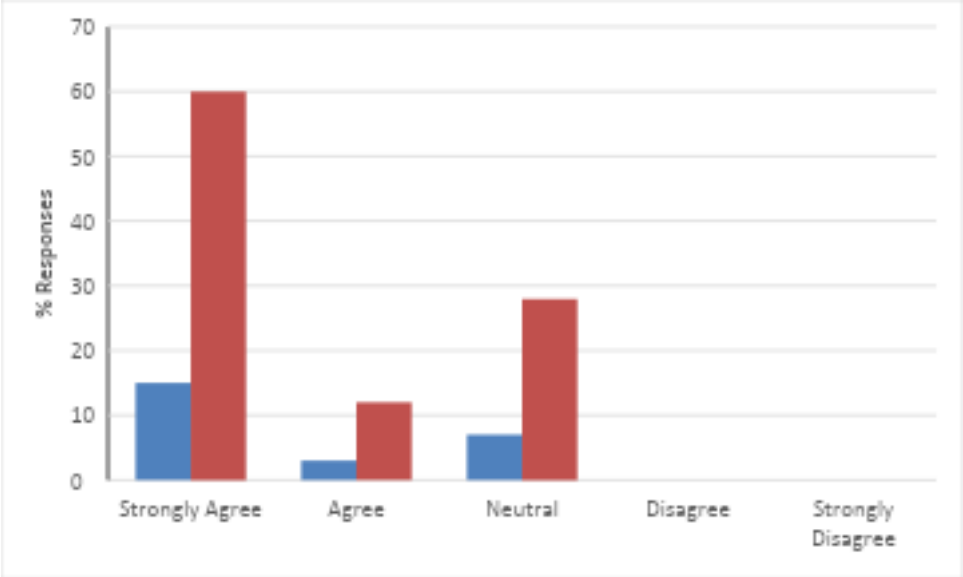


Fig. 50b: Household's knowledge of changing climate in Epe, Lagos State

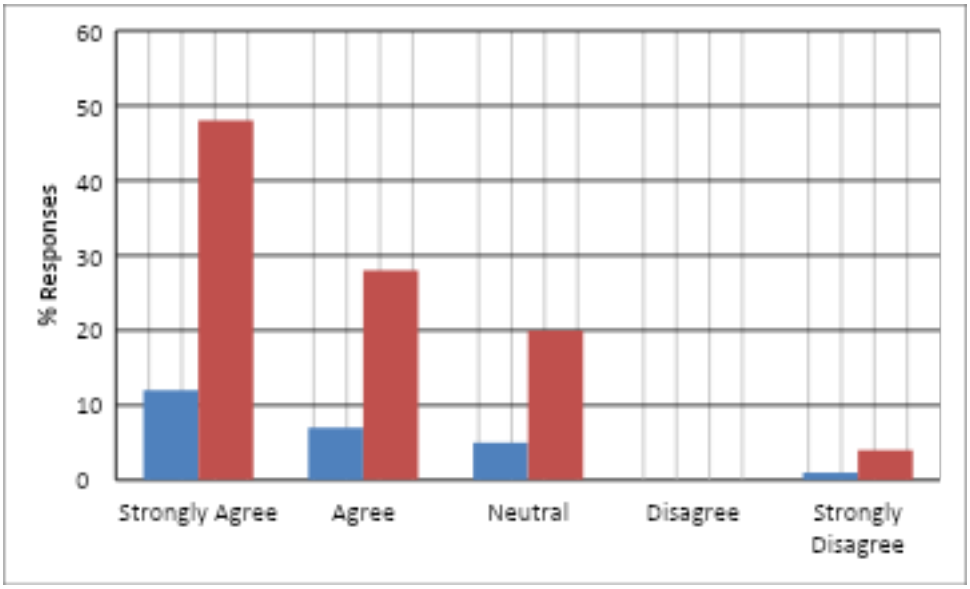


Fig. 50c: Household's knowledge of changing climate in Jos Town, Plateau State

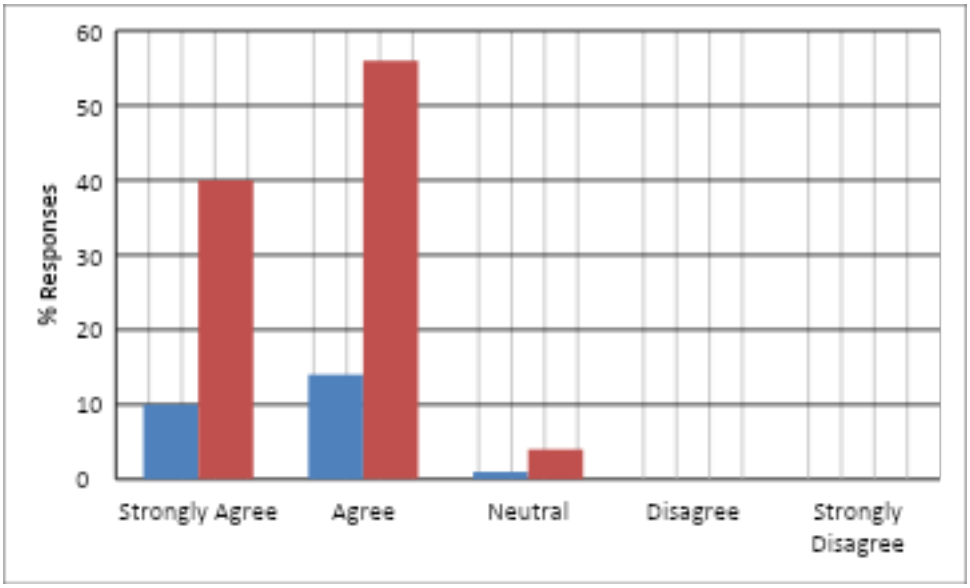


Fig. 50d: Household's knowledge of changing climate in the FCT, Abuja

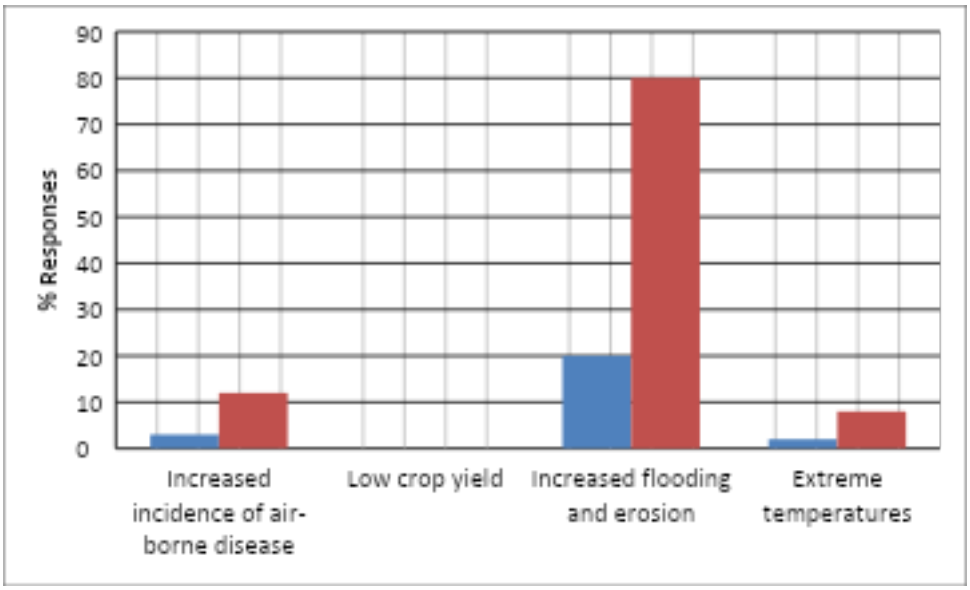


Fig. 51a: Perceived indicators of climate change in Benin City, Edo State: Responses from Household

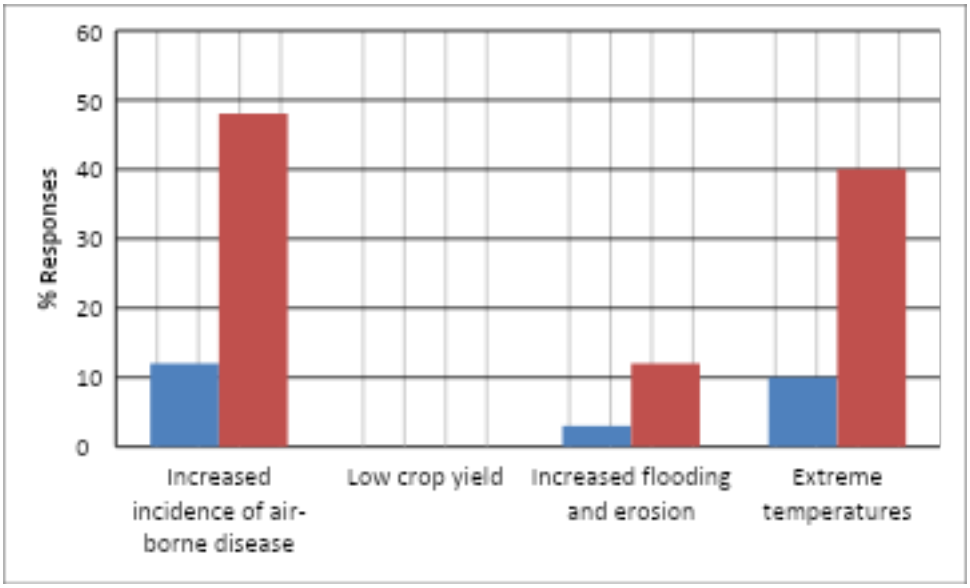


Fig. 51b: Perceived indicators of climate change in Epe, Lagos State: Responses from Household

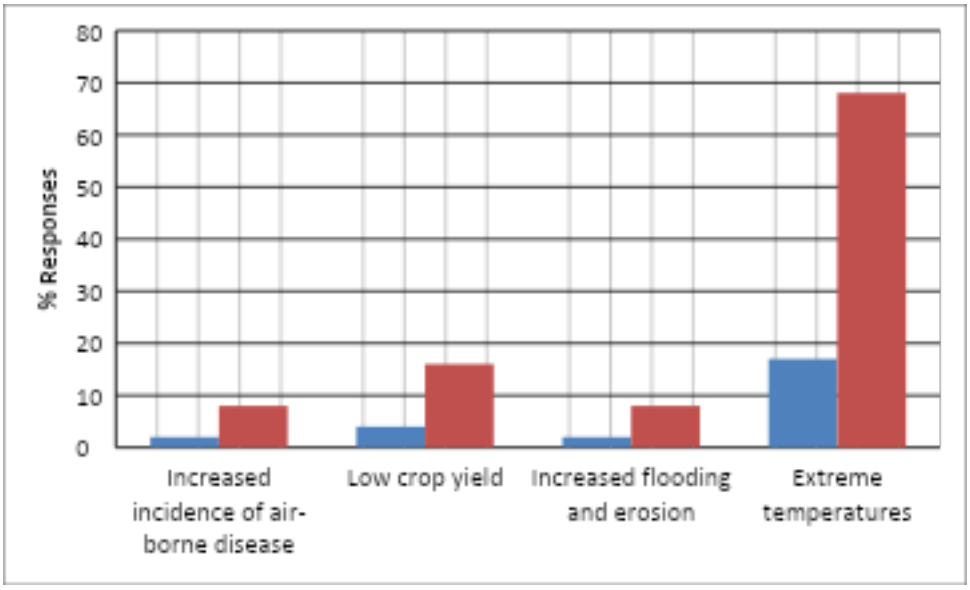


Fig. 51c Perceived indicators of climate change in Jos Town, Plateau State: Responses from Household

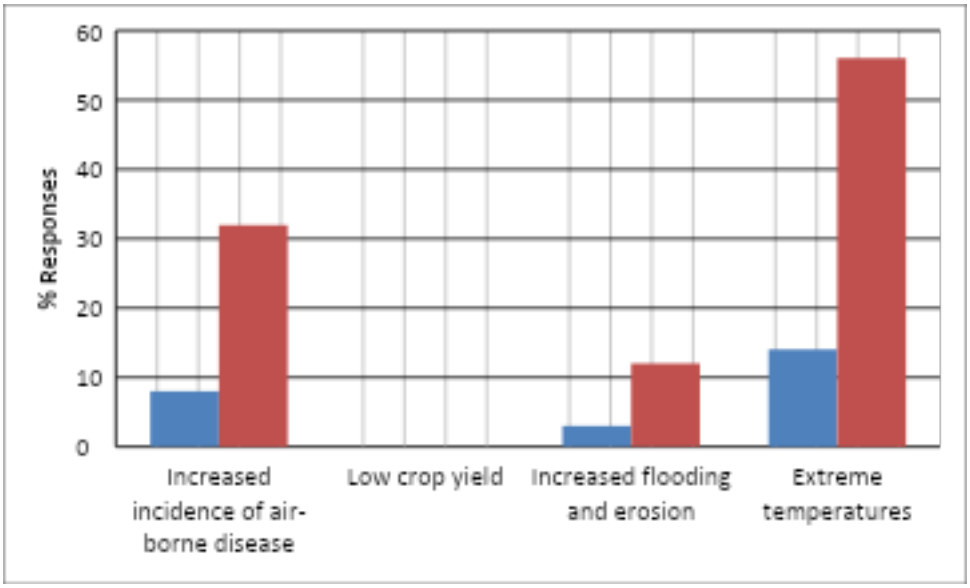


Fig. 51d: Perceived indicators of climate change in the FCT, Abuja: Responses from Household

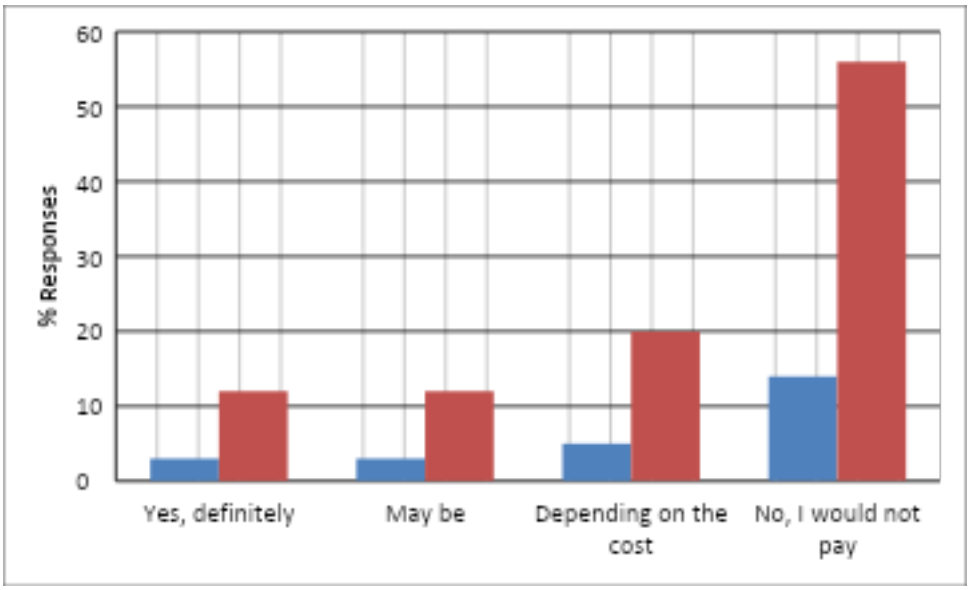


Fig. 52a: Household willingness to pay for training in waste compositing: Benin City, Edo State

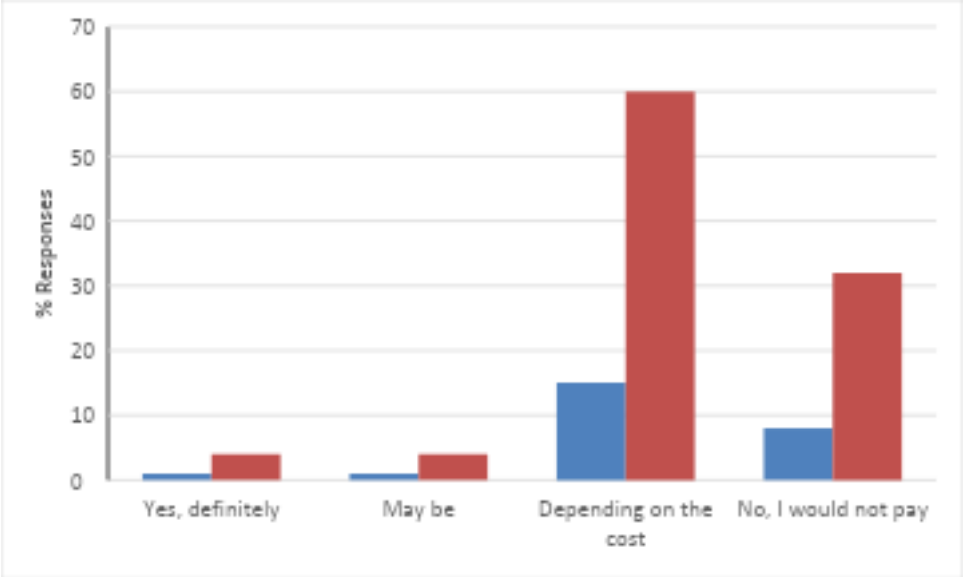


Fig. 52b: Household willingness to pay for training in waste compositing: Epe, Lagos State

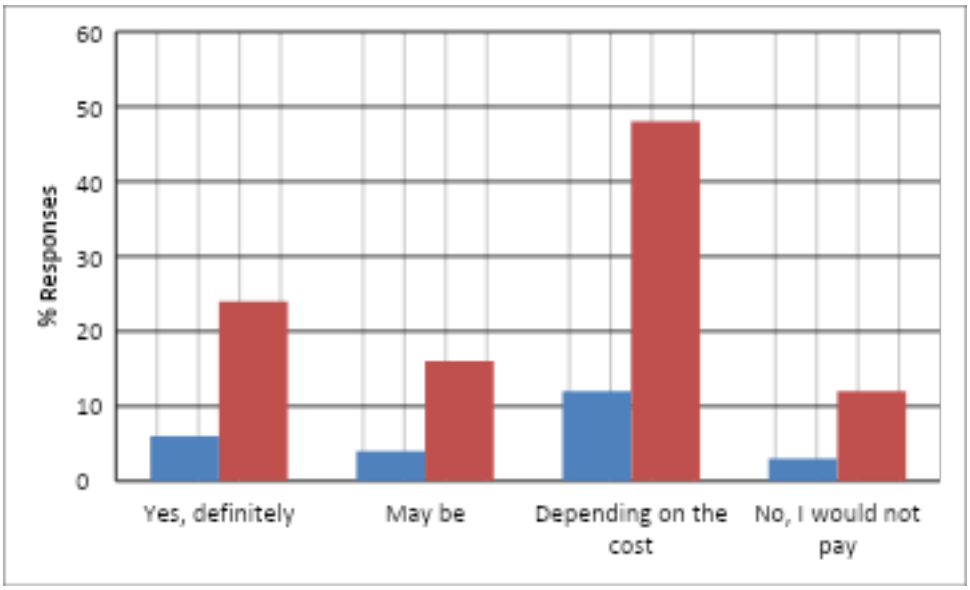


Fig. 52c: Household willingness to pay for training in waste compositing: Jos Town, Plateau State

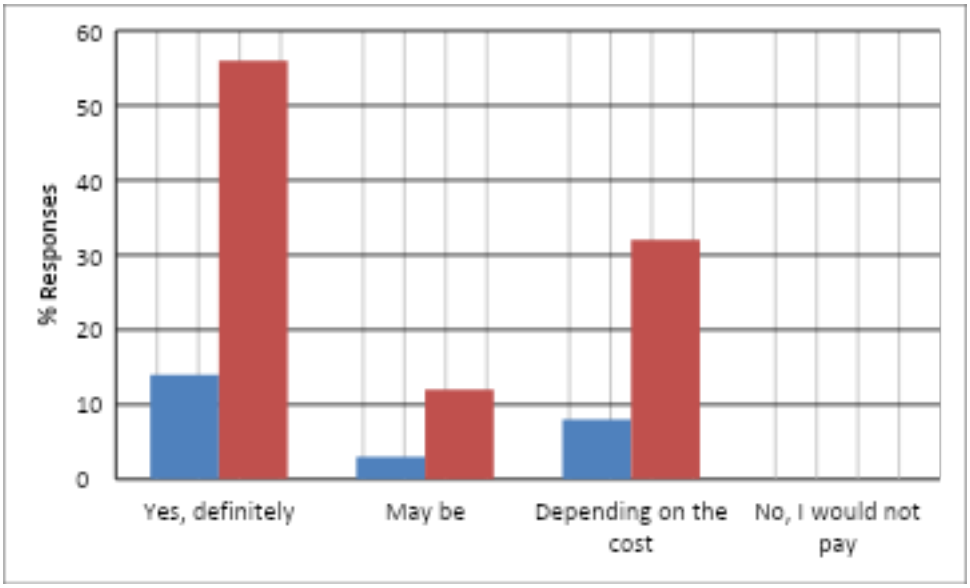


Fig. 52d: Household willingness to pay for training in waste compositing: FCT, Abuja

11.7. Baseline Results: Views and Perceptions of Sampled Fruit Sellers About MSW And Material Recovery Across Nigeria

Predominant waste type at fruits markets

In Fig. 53a-d, it can be seen that left over fruit, vegetable and peels are the predominant types of waste generated in in markets. Common fruits and vegetables sold at these markets include tomatoes, pawpaw, banana, avocado, citrus fruits, pineapple, watermelon, oranges, and various types of apples and grapes. Variety of vegetables, including leafy greens like spinach and amaranth, etc are also sold in these markets. These fruits and vegetables become waste due to inadequate storage and transportation infrastructure, poor handling practices, and limited access to markets, leading to post-harvest losses and spoilage, and the situation is worst the peak of fruit and rainy season. Fruit waste, abandoned in landfills/dumpsites, can be a significant source of methane production, and while at the same time when diverted from waste stream can be a source of material for composting.

Waste disposal handling in the market

In Figs. 54a-d, results of waste disposal handling by fruit sellers are presented. In Benin City, fruits/vegetable sellers take their waste to designated point where appropriate authorities (Private vendors) will collect them to final disposal points. Collection of these wastes is on weekly basis.

Other methods of waste handling methods include disposal in any available open space. More so, 24% of the respondents indicated that they dispose of their waste in comingled form while another 24% have separate bin for perishables. In Epe, Lagos State, open dumping and anywhere dumping of waste is still a common practice, though this waste are later evacuated. More so, this organic waste is disposed in comingled form (other waste included). This handling method is both environmentally unfriendly as such dumping ground become breeding grounds for disease vectors, and contamination of water sources leading to significant health risks, including respiratory problems, waterborne diseases, and vector-borne illnesses. Other characteristics of waste handing at markets in Epe are the irregular collection by LAWMA, a situation which has increase environmental concerns, including air pollution. In Jos town, and the FCT, Abuja, majority of waste from fruit sellers come in comingled form and anyhow dumping at unspecified locations is also a common practice. Only a few fruit sellers have separate container for organic waste.

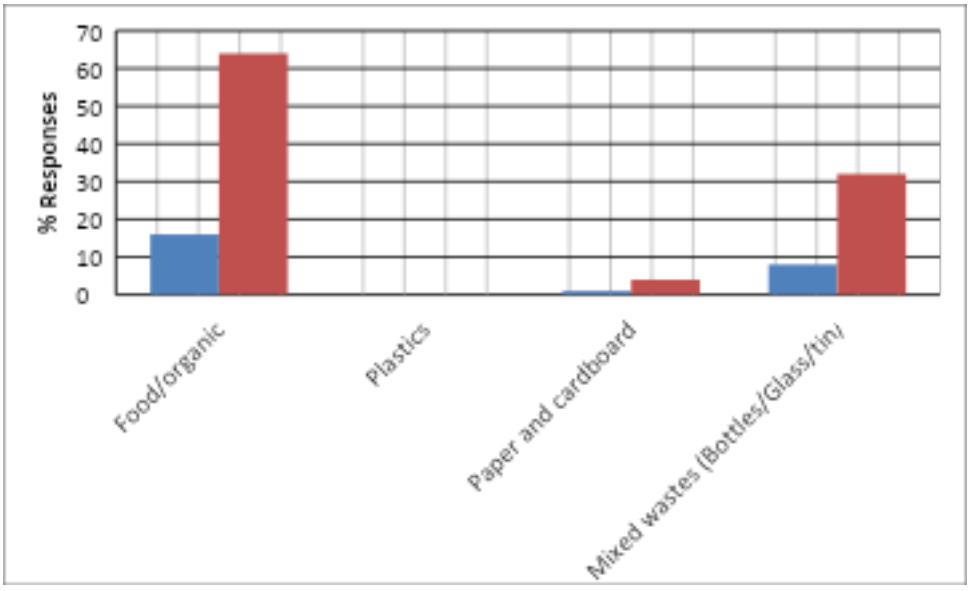


Fig.53a: Predominant waste type generated by fruits sellers/vegetable, in Benin City, Edo State

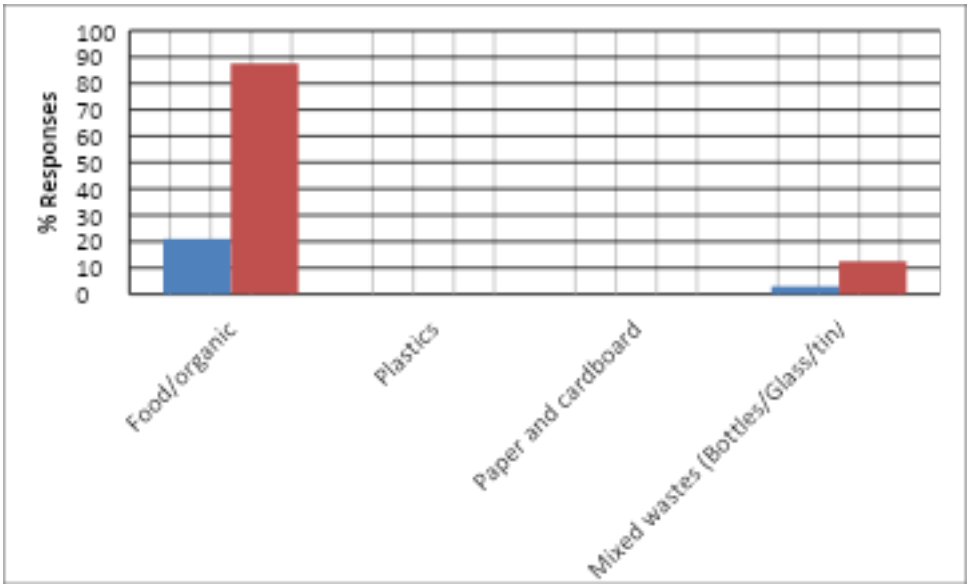


Fig.53b: Predominant waste type generated by fruits/vegetables sellers in Epe, Lagos State

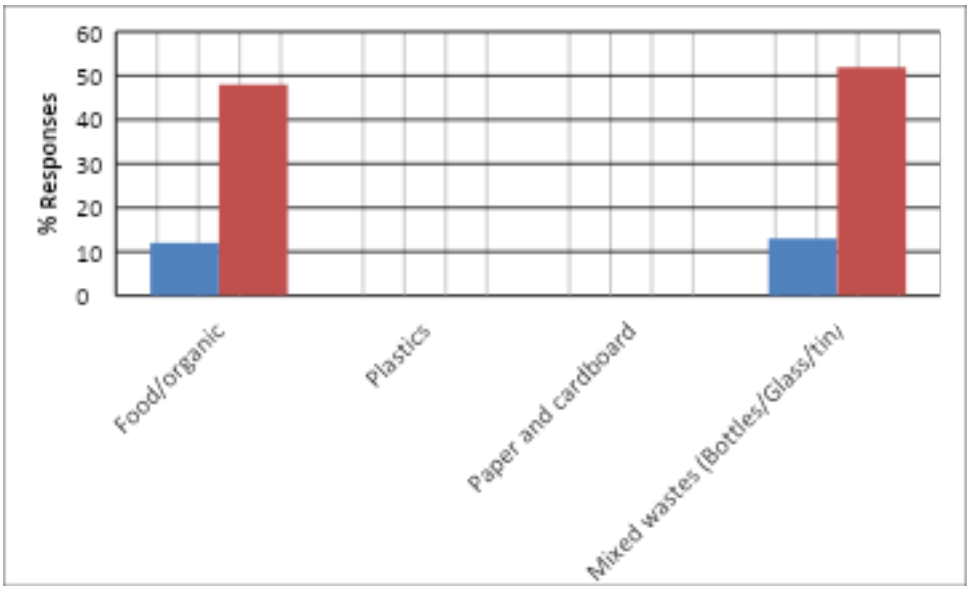


Fig. 53c: Predominant waste type generated by fruits/vegetables sellers in Jos town, Plateau State

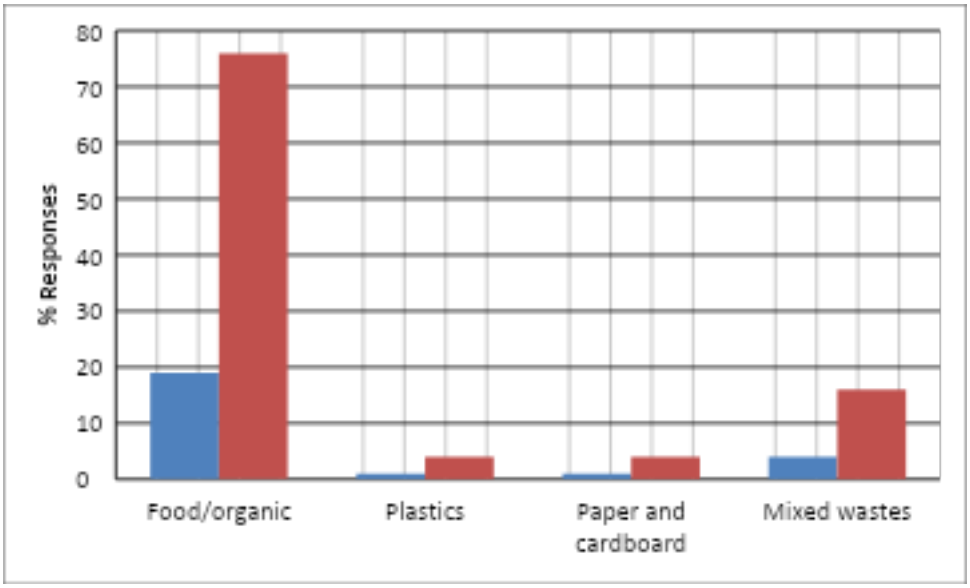


Fig. 53d: Predominant waste type generated by fruits/vegetables sellers in the FCT, Abuja

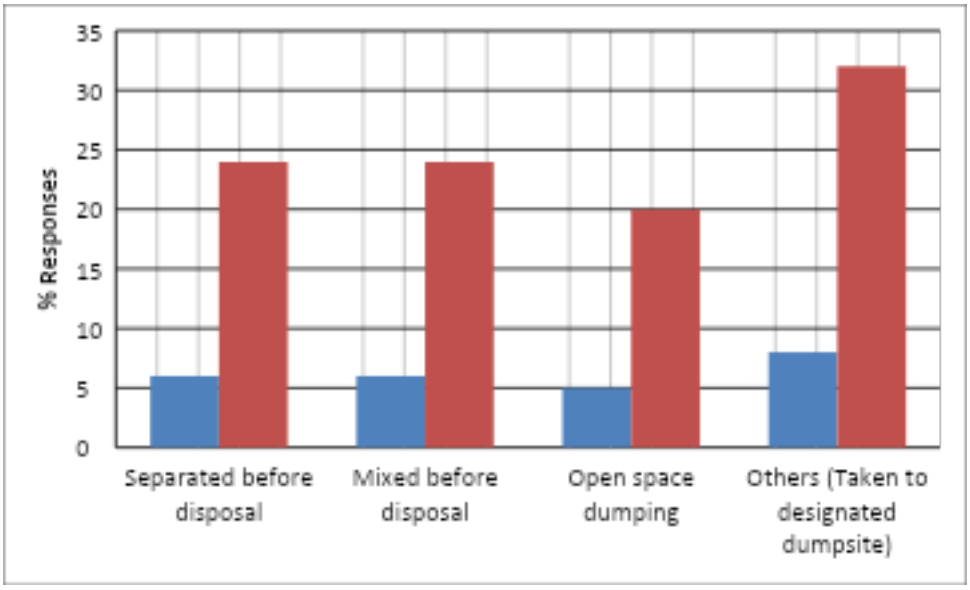


Fig.54a: Waste disposal Practices by Fruit/vegetables sellers, Benin City, Edo State

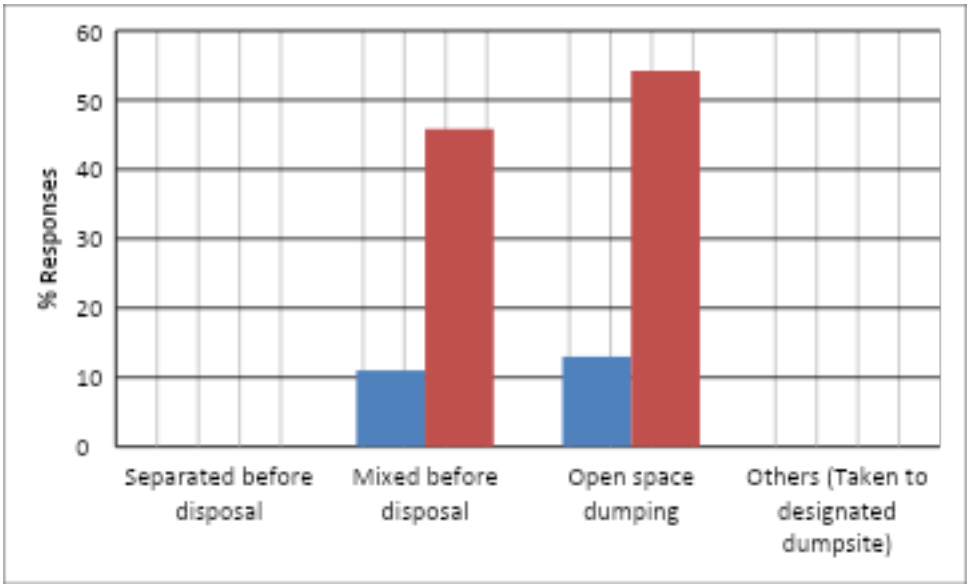


Fig. 54b: Waste disposal Practices by Fruit/vegetables sellers, Epe, Lagos State

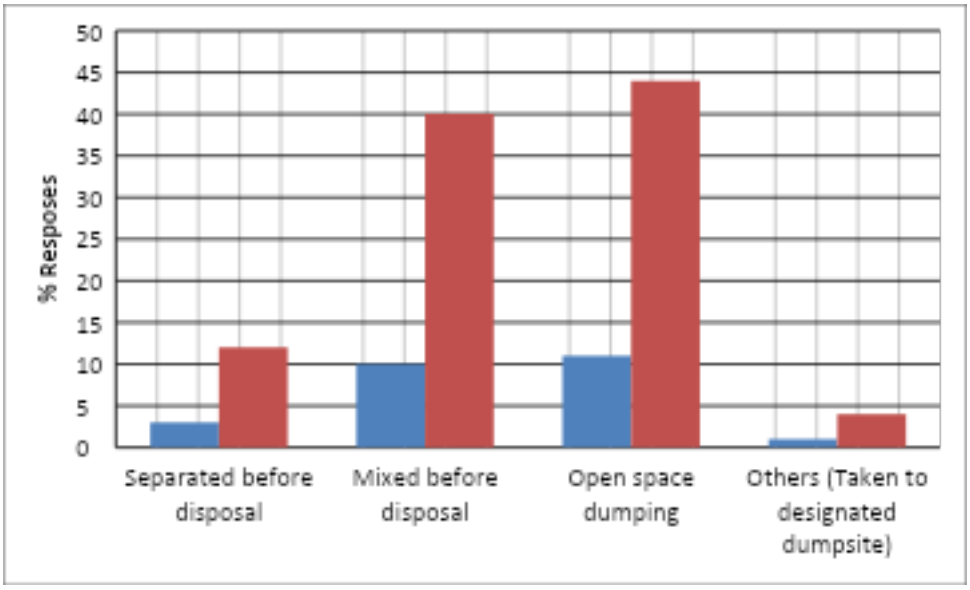


Fig.54c: Waste disposal Practices by Fruit/vegetables sellers, Jos Town, Plateau State

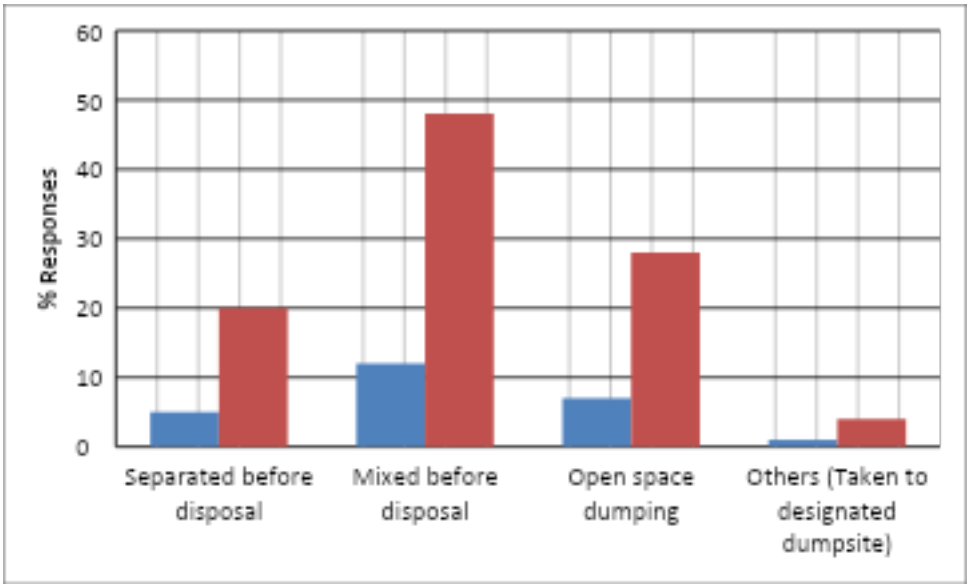


Fig.54d:: Waste disposal Practices by Fruit/vegetables sellers, FCT, Abuja

Factor affecting sustainable management in the Markets

In Figs. 55a-d factors affecting sustainable management of Market waste are presented. From the Figures, key characteristics of waste handing at surveyed markets in Benin City and Jos town are insufficient waste collection bins (In Benin City individuals provide collection bins not government). This is followed by poor solid waste management awareness. Irregular collection of waste by vendors constitutes 12% of factors affecting sustainable management of Market waste. In Epe, Lagos irregular collection by LAWMA is considered a limiting factor towards sustainable waste management in the market space, a situation which has increase environmental concerns, including air pollution. Also, in Epe, Lagos State, there is the issue of poor solid waste management awareness/sensitization. In the FCT, Abuja, insufficient waste collection bins (32%) and poor implementation of penalties for improper solid waste disposal are main hindrance to sustainable solid waste management at markets.

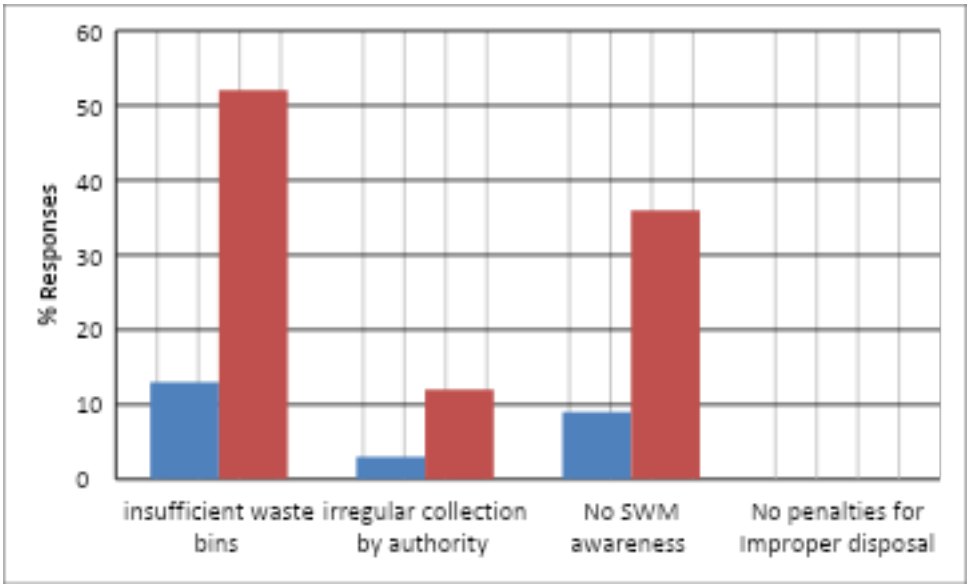


Fig. 55a: Factors hindering sustainable management of Market waste, Benin City, Edo State

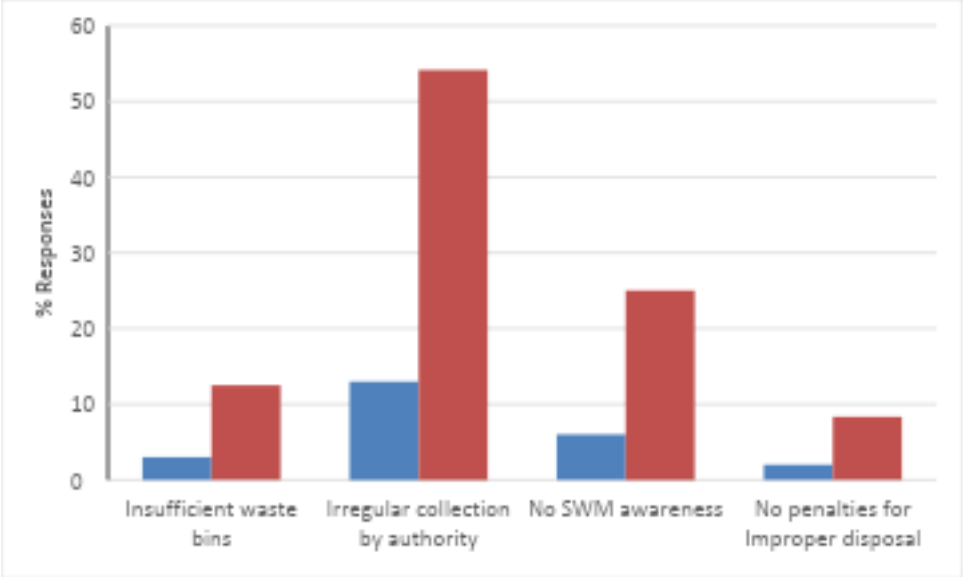


Fig. 55b: Factors hindering sustainable management of Market waste, Epe, Lagos State

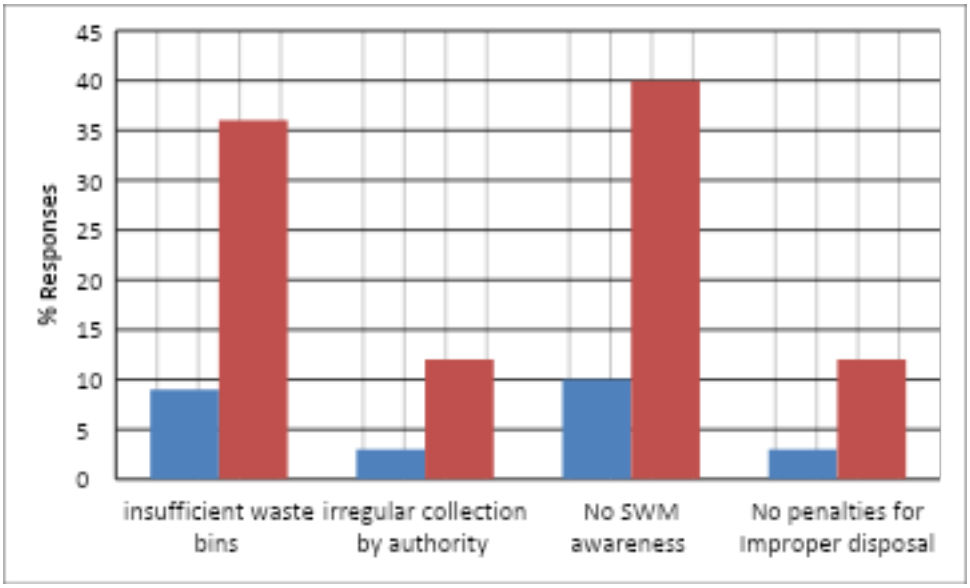


Fig. 55c: Factors hindering sustainable management of Market waste, Jos Town, Plateau State

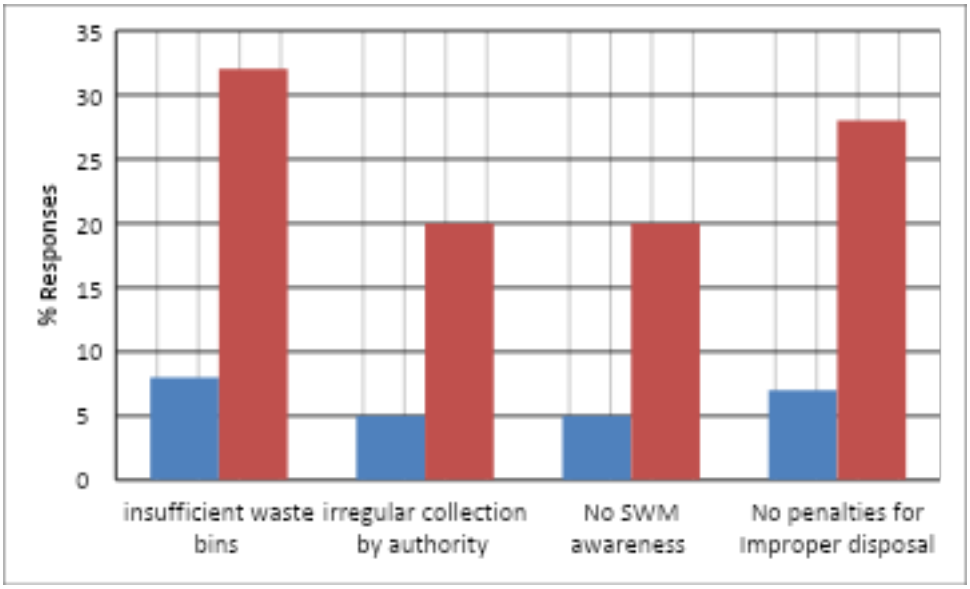


Fig. 55d: Factors hindering sustainable management of Market waste, FCT, Abuja

Barrier to Waste Separation, Reuse and Composting

In Figs 56a-d, results of perceived barrier to waste separation, reusing and composting amongst fruits sellers are presented. In Benin City and Jos town, perceived barrier to waste separation, reusing and composting amongst fruits sellers are the lack of awareness, while respondents in Lagos and the FCT, Abuja indicated the effects of multiple factors ranging from lack of awareness, not having access to composting facility, lack of government supports to cultural

issues. In Figs 57 a-d, results of fruits/vegetables sellers' awareness of state government/municipal policies on waste reuse are presented. In Benin City, Jos twon and FCT, Abuja, about 96% (Benin City), 76% (Jos town) and 36% (FCT) are not aware that policies exist on waste re-use, a situation which compounds sustainable solid waste management in marketplaces. For those who are aware of composting in Epe, Lagos State and the FCT, Abuja, they lack of enforcement of such policies. Most State Government, for example in Lagos, Edo State and the FCT, Abuja have embarked on several initiatives on waste minimization including zero waste. However, these initiatives and policies are either not enforceable in the markets or many are not aware these policies exist. Notwithstanding, the low level of awareness on composting, majority of the sampled market respondents indicated that market place is ideal for source segregation and are willing to participate in source separation and composting. This is especially true of respondents in FCT, Abuja (44%), Epe Lagos State (70%). In Jos town and Benin City about 36% and 68% are neutral about active participation in composting (Figs 58a-d). Respondents also indicated that, market population to be actively involved in the composting initiative there will be need for more awareness campaign especially in Benin City (36%), Epe, Lagos State (66.7%) and the FCT, Abuja (72%) . However, in Jos town, respondents' indicated that government must provide supports through sponsored training and provision of sorting/composting facility (59a-d). More so, respondents indicated that some enabling factors must be in place to guarantee the sustainability of material recovery plan such as Educational level (Ability to read manual) (36%), age (28%) and income level (24%) for market population in Benin City, government support through free training (33%), educational level (33%), income level (29.2%) for market population in Epe, Lagos, Educational level (50%) and government support for market population in Jos town and, government supports (40%) and income level amongst market population in the FCT, Abuja (Figs 60).

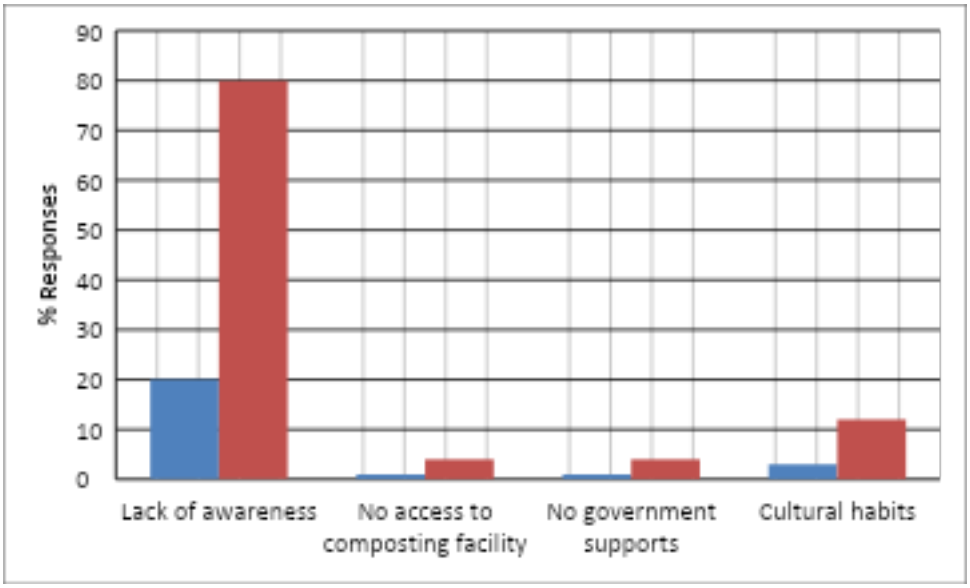


Fig. 56a: Perceived Barrier to Waste Separation, reusing and composting amongst fruits sellers in Benin City, Edo State

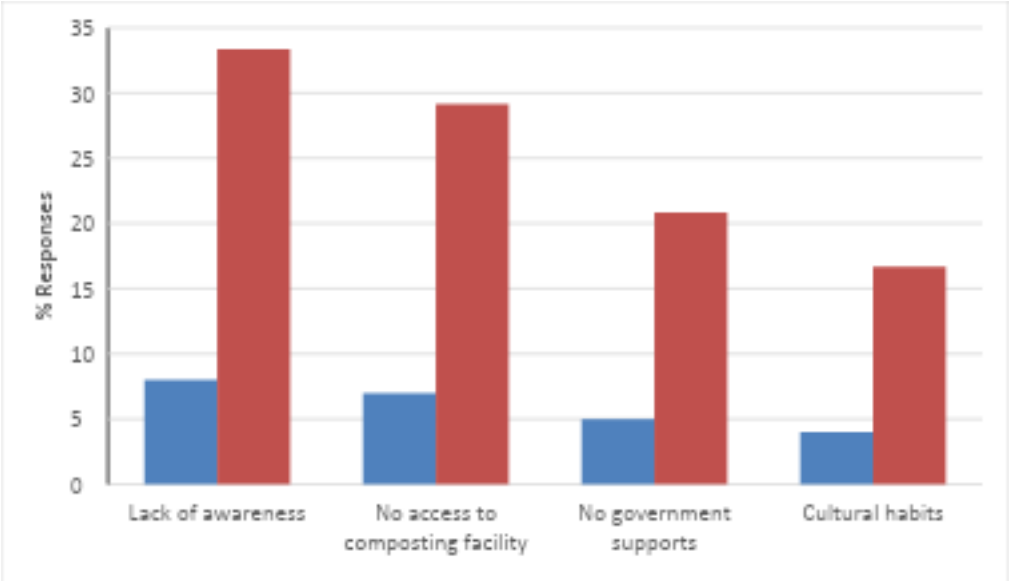


Fig. 56b: Perceived Barrier to Waste Separation, reusing and composting amongst fruits sellers in Epe, Lagos State

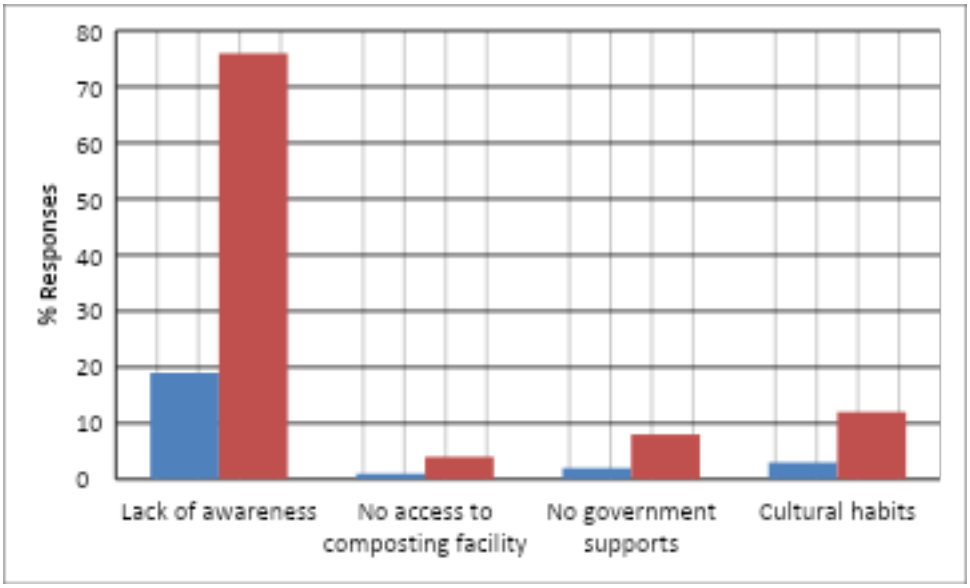


Fig. 56c: Perceived Barrier to Waste Separation, reusing and composting amongst fruits sellers in Jos Town, Plateau State

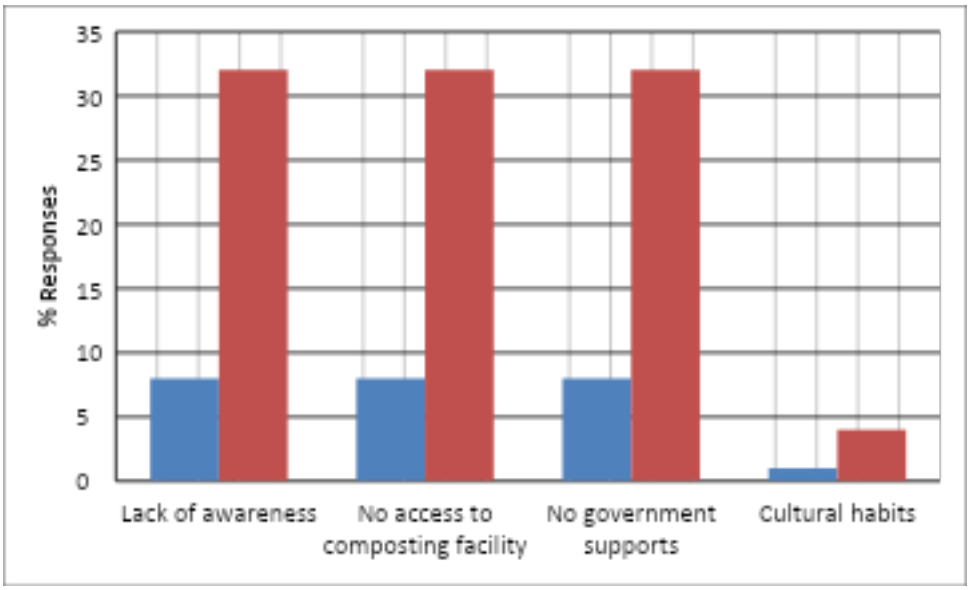


Fig. 56d: Perceived Barrier to Waste Separation, reusing and composting amongst fruits sellers in the FCT, Abuja

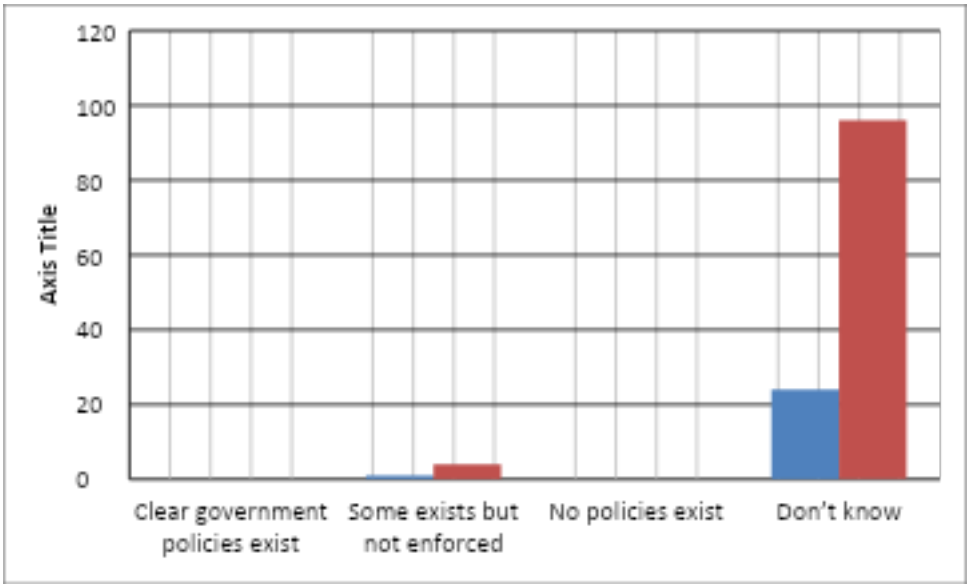


Fig. 57a: Fruits/vegetables sellers' awareness of state government policies on waste reuse in Benin City, Edo State

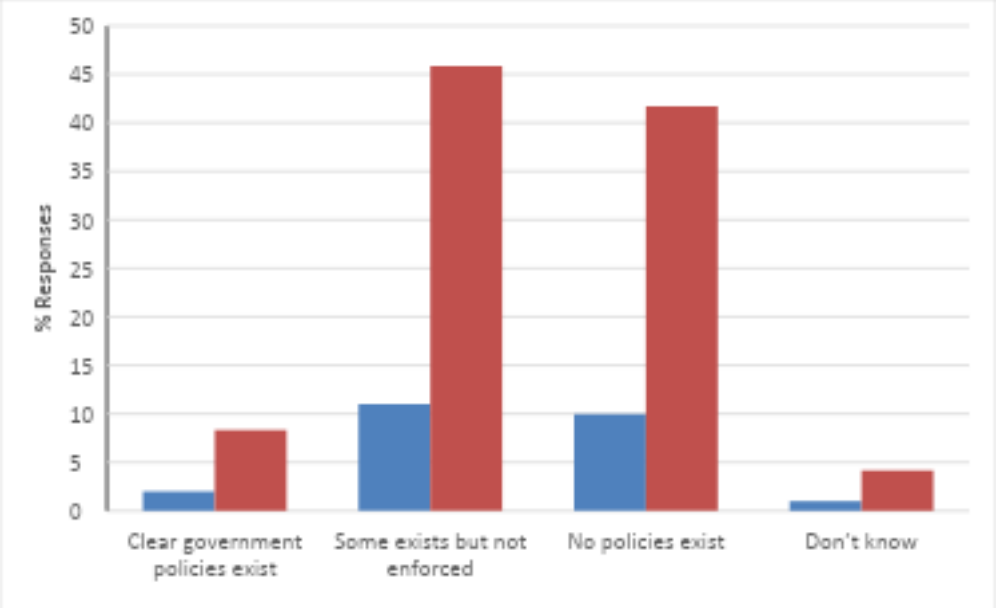


Fig. 57b: Fruits/vegetables sellers' awareness of state government policies on waste reuse in Epe, Lagos State

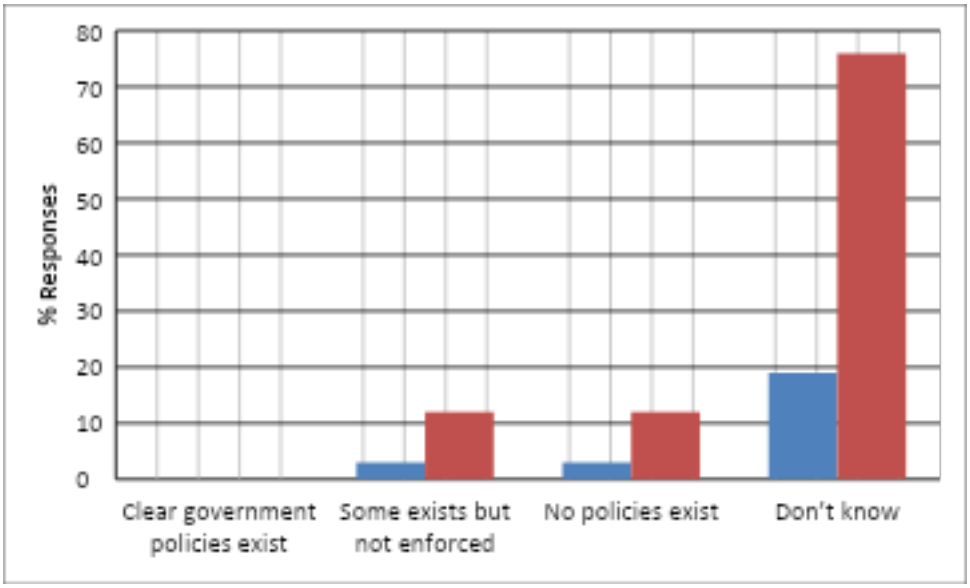


Fig. 57c: Fruits/vegetables sellers' awareness of state government policies on waste reuse in Jos Town, Plateau State

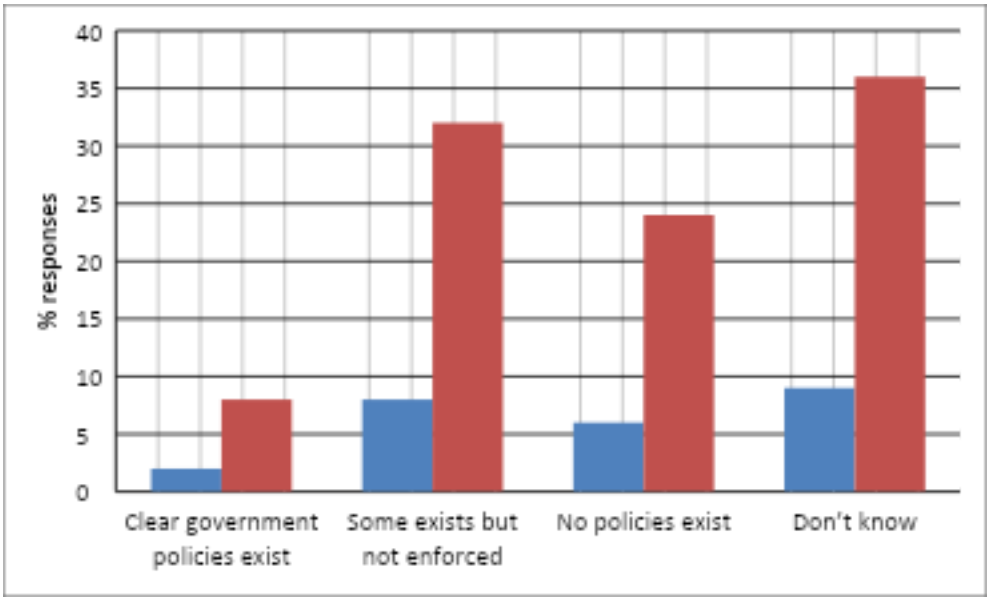


Fig. 57d: Fruits/vegetables sellers' awareness of state government policies on waste reuse in the FCT, Abuja

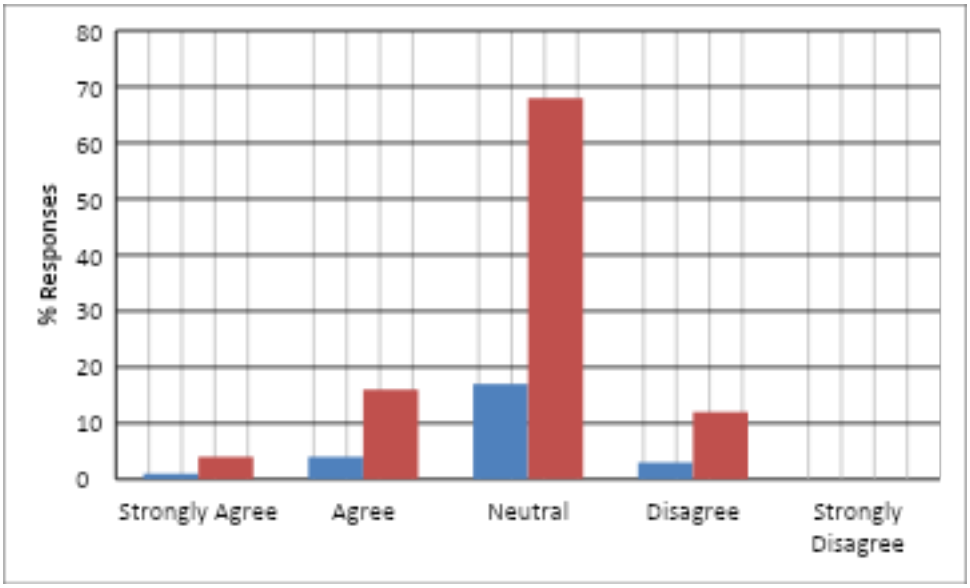


Fig. 58a: Perception that markets is ideal for source separation, Benin City, Edo State

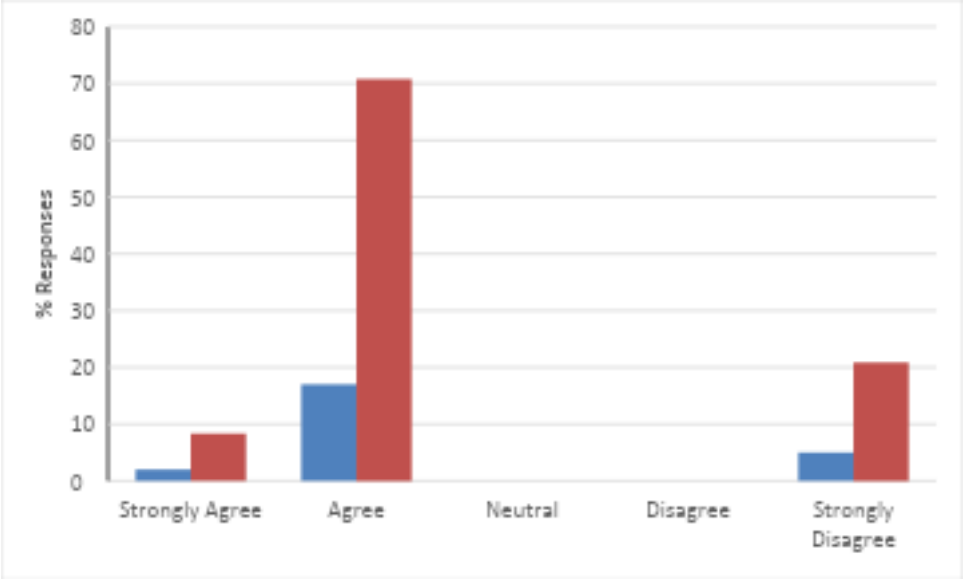


Fig. 58b: Perception that markets is ideal for source separation, Epe, Lagos State

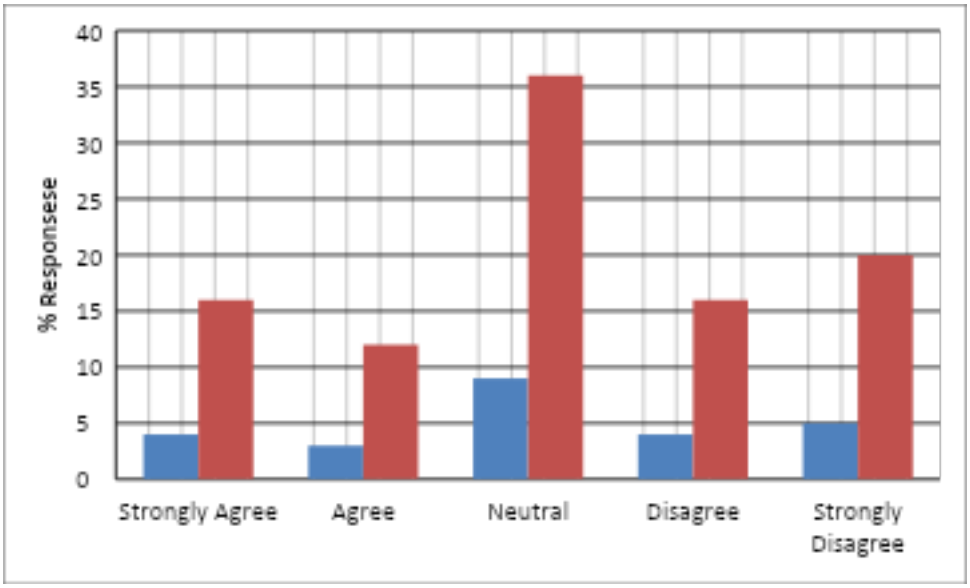


Fig. 59c: Perception that markets is ideal for source separation, Jos Town, Plateau State

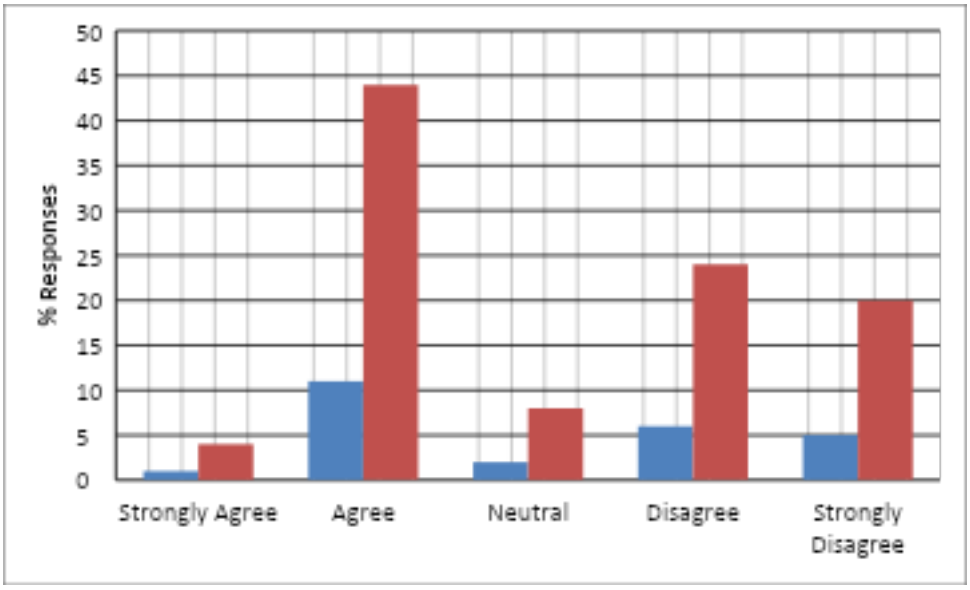


Fig. 58d: Perception that markets is ideal for source separation, FCT, Abuja

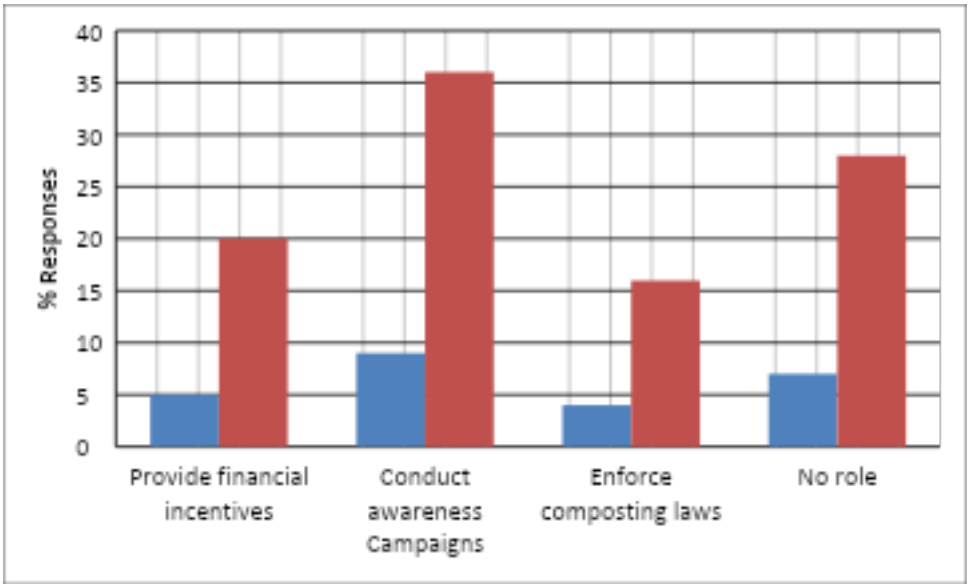


Fig. 59a: Fruits/vegetable sellers views on the roles of government in waste recovery in Benin City, Edo State

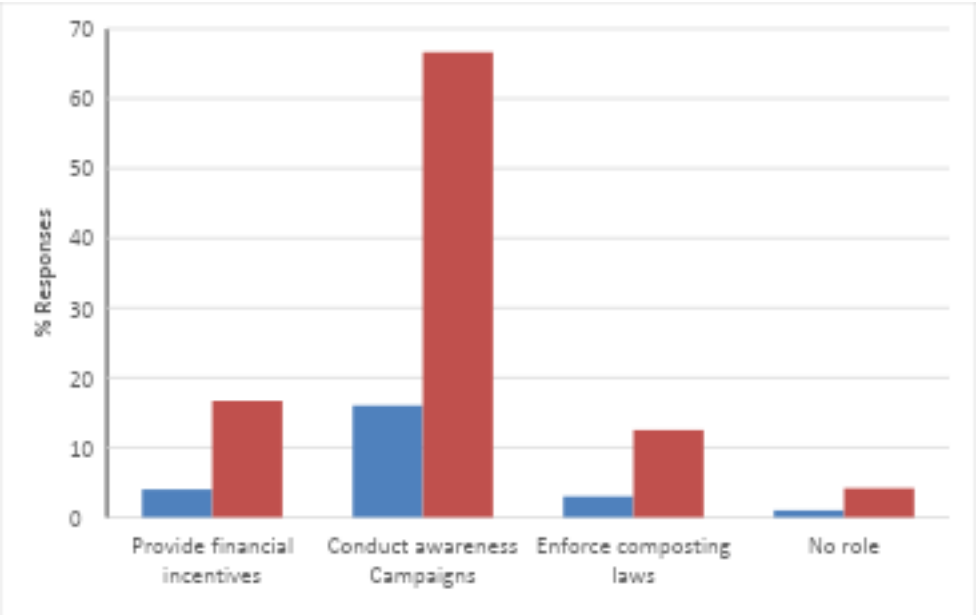


Fig. 59b: Fruits/vegetable sellers views on the roles of government in waste recovery in Epe, Lagos State

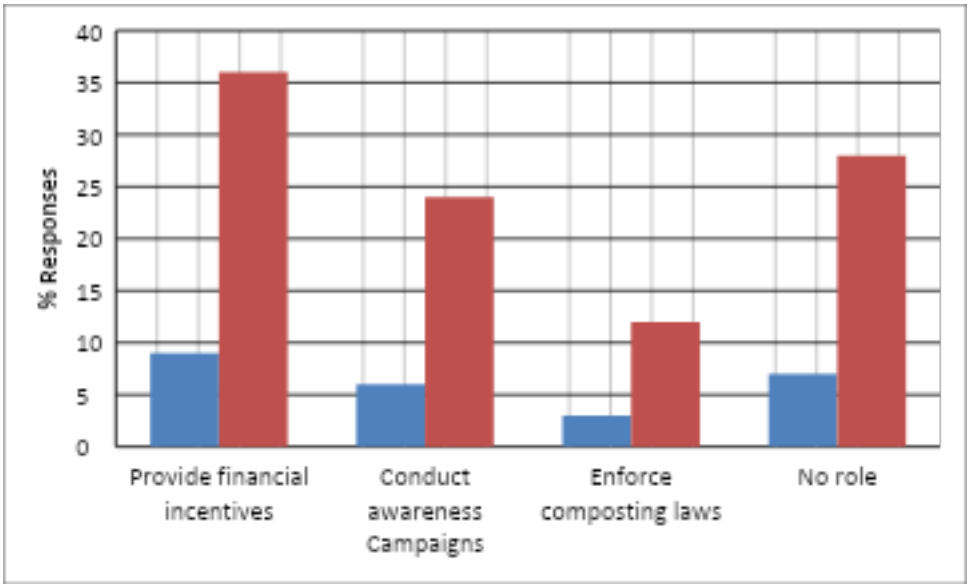


Fig. 59c: Fruits/vegetable sellers views on the roles of government in waste recovery in Jos Town, Plateau State

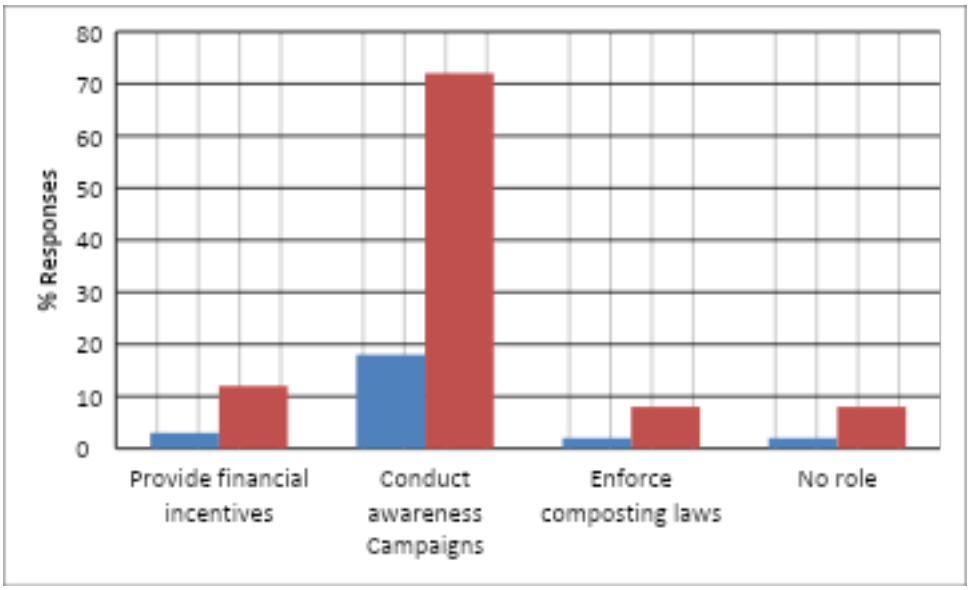


Fig. 59d: Fruits/vegetable sellers views on the roles of government in waste recovery in the FCT, Abuja

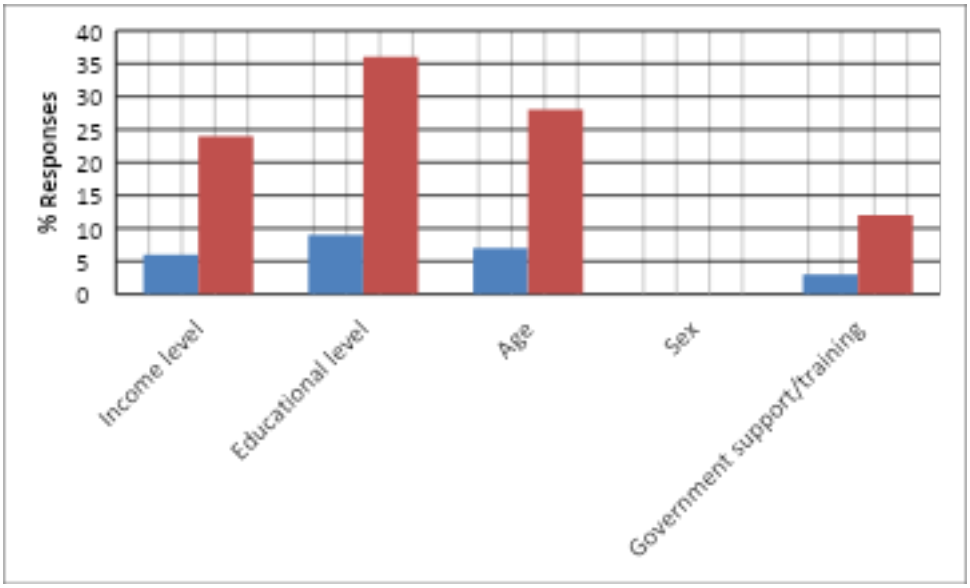


Fig. 60a: Enabling factors to participate in material recovery: Responses from fruits/vegetable sellers in Benin City, Edo State

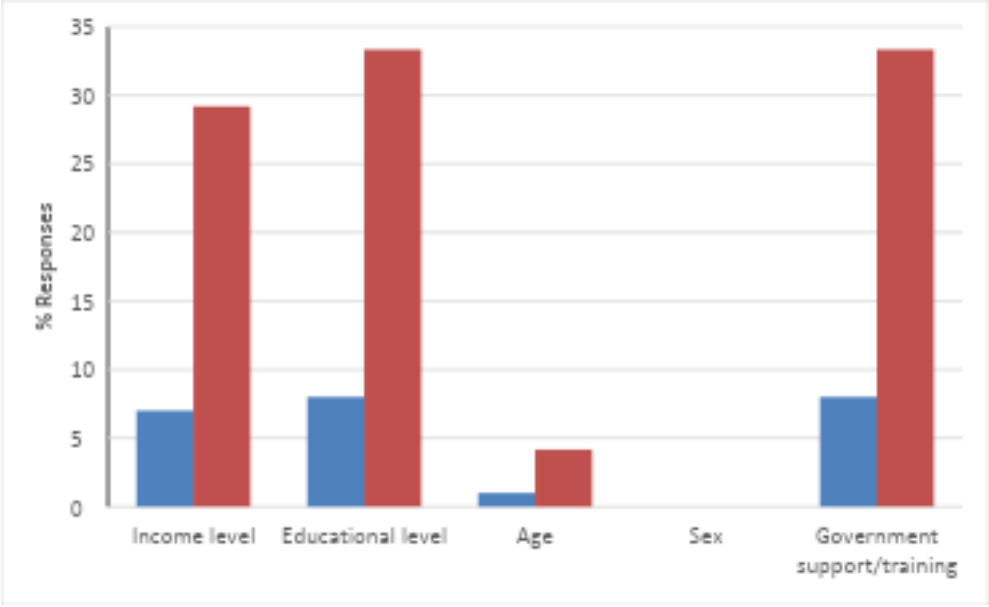


Fig. 60b: Enabling factors to participate in material recovery: Responses from fruits/vegetable sellers in Epe, Lagos State

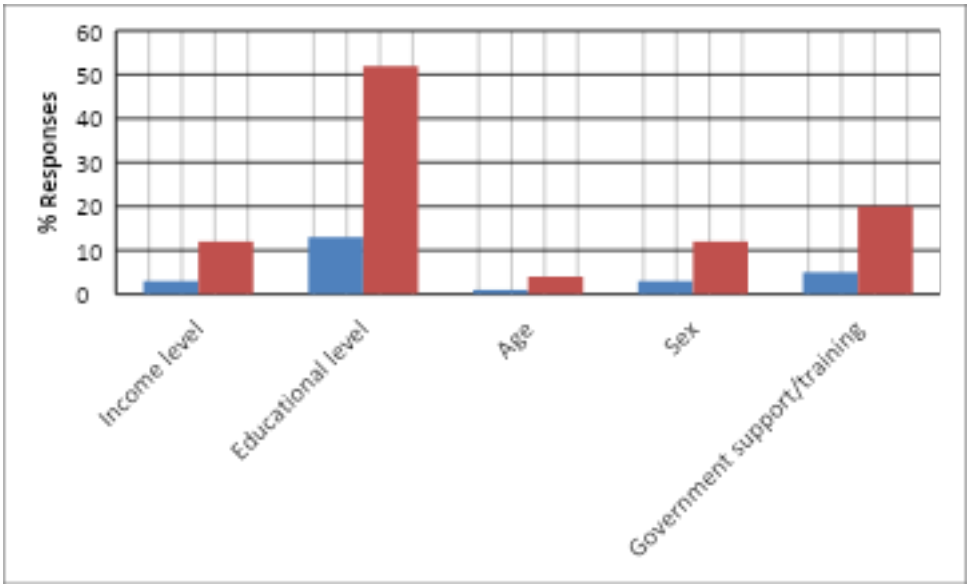


Fig. 60c: Enabling factors to participate in material recovery: Responses from fruits/vegetable sellers in Jos Town, Plateau State

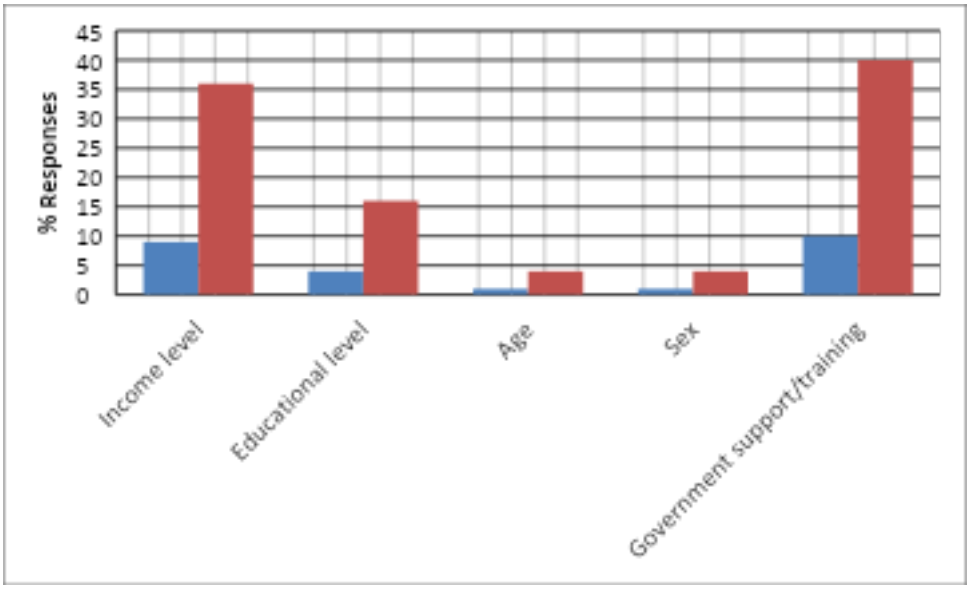


Fig. 60b: Enabling factors to participate in material recovery: Responses from fruits/vegetable sellers in the FCT, Abuja

11.8. Baseline Results: Views and Perceptions of Sampled Informal Waste Pickers About MSW And Material Recovery Across Nigeria

Common Recovered Materials by Informal Waste Pickers

In Figs 61a-d, predominant types of waste recovered by informal waste pickers are plastics across all the survey state and the FCT, Abuja. The high rate of plastics and metals scavenging is due to the high demand for them. Metals, glass/bottles are also in high demand. Paper/cardboard waste can be regarded as organic waste because it is derived from plant matter (specifically, wood pulp) and is biodegradable, meaning it can decompose naturally. However, the choice and rate of scavenging is dependent on season. Recovery of material takes place at dumpsites and on streets. There is a low rate of paper scavenging during the rainy season. However, the season does not affect plastics and metals. Organic waste is currently not scavenged because there is no market for degradable. However, in the FCT, herders-men bring their cows to the dumpsite to feed them (Plate 64). These materials when recovered are transported to designated centres where they are weighed and then sold to vendors at collection centre or through middlemen or directly to recyclers as we observed in Epe, Lagos State (Figs. 62a-d).

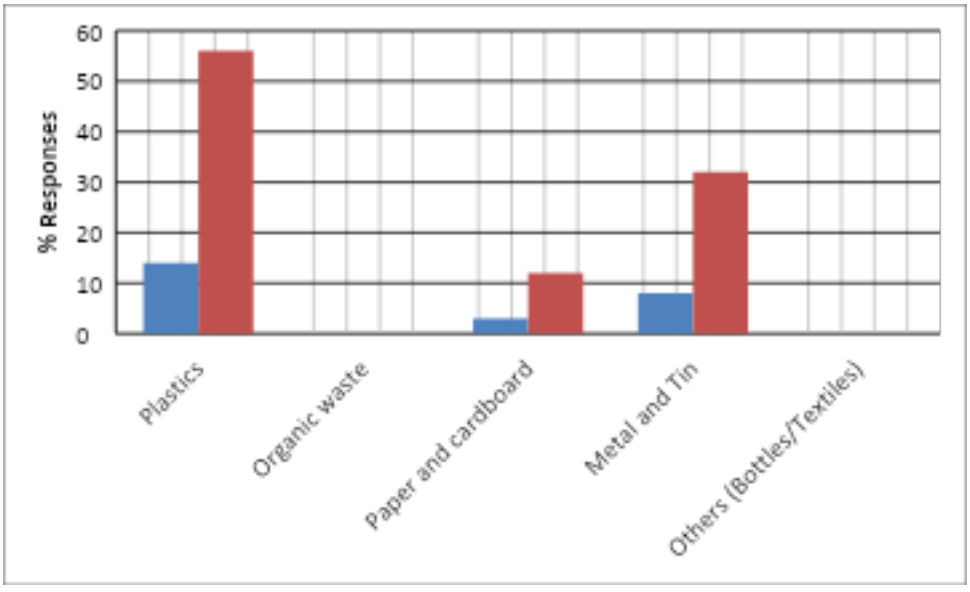


Fig. 61a: Predominant types of waste scavenged by informal waste pickers in Benin City, Edo State

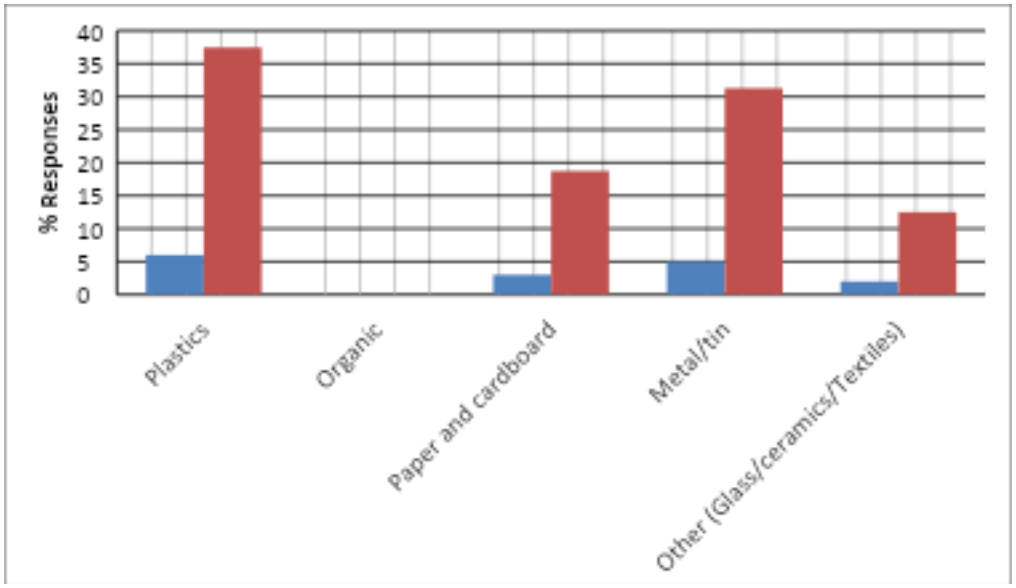


Fig. 61b: Predominant types of waste scavenged by informal waste pickers in Epe, Lagos State

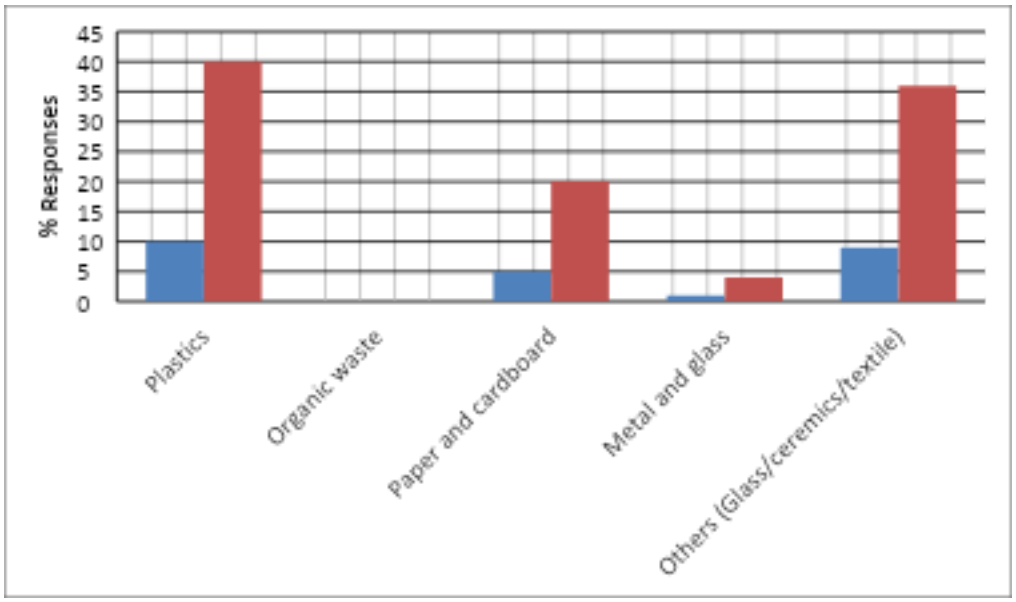


Fig. 61c: Predominant types of waste scavenged by informal waste pickers in Jos Town, Plateau State

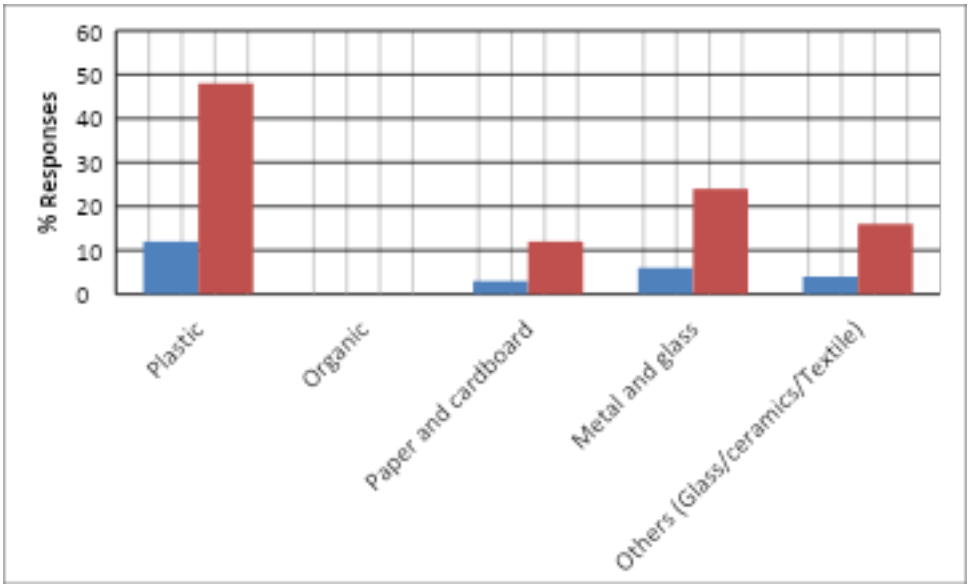


Fig. 61d: Predominant types of waste scavenged by informal waste pickers in the FCT, Abuja

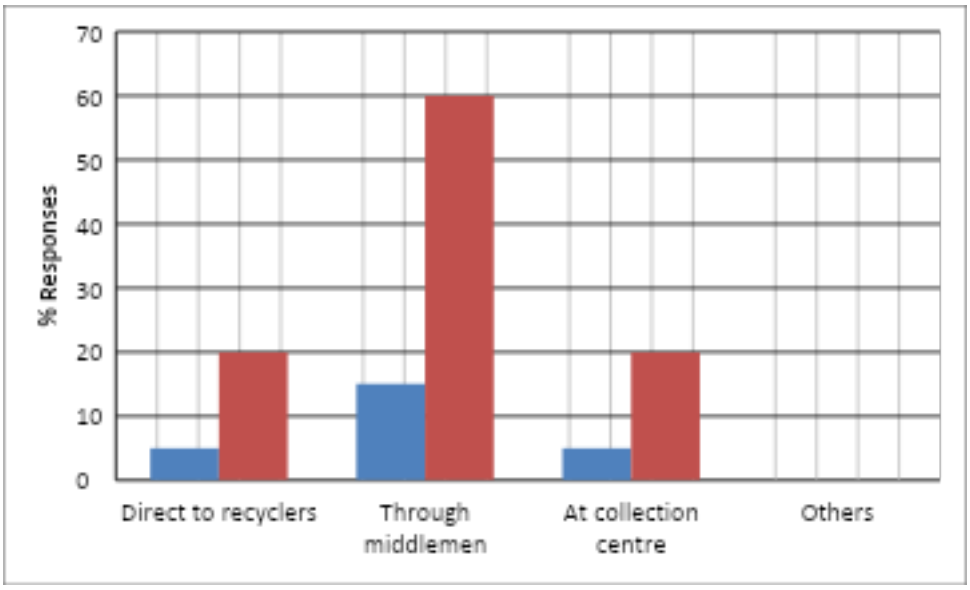


Fig. 62a: Sale arrangement for recovered materials in Benin City, Edo State

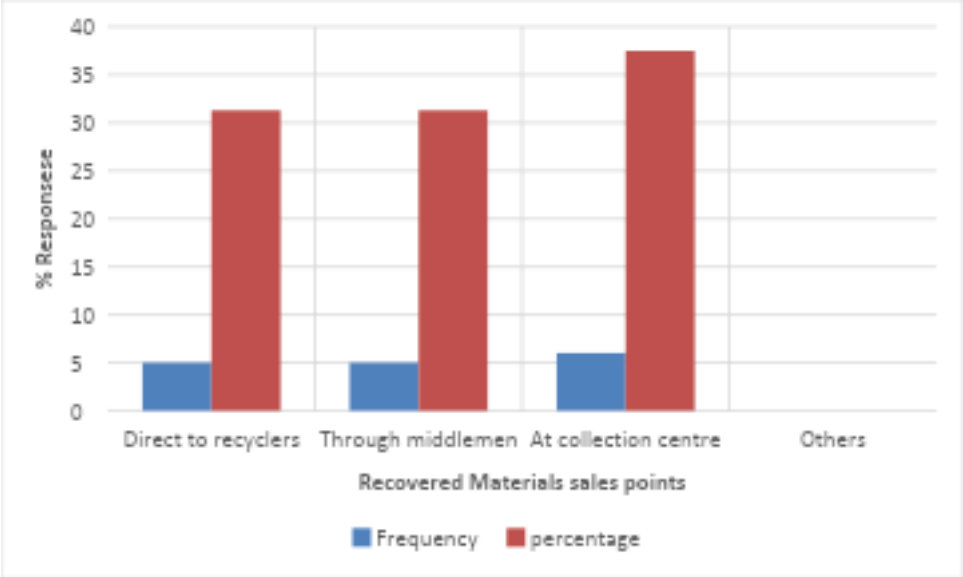


Fig. 62b: Sale arrangement for recovered materials in Epe, Lagos State

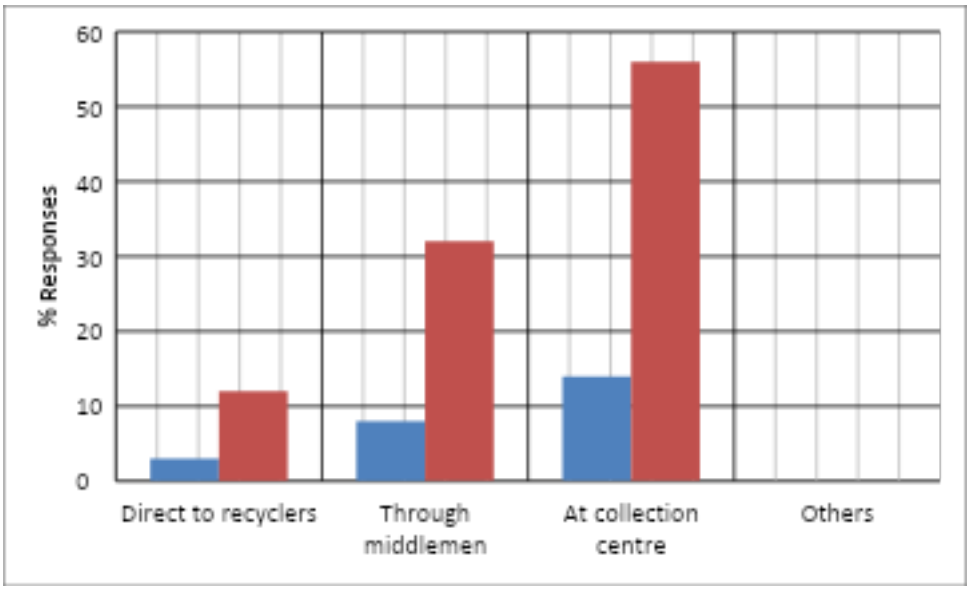


Fig. 62c: Sale arrangement for recovered materials in Jos Town, Plateau State

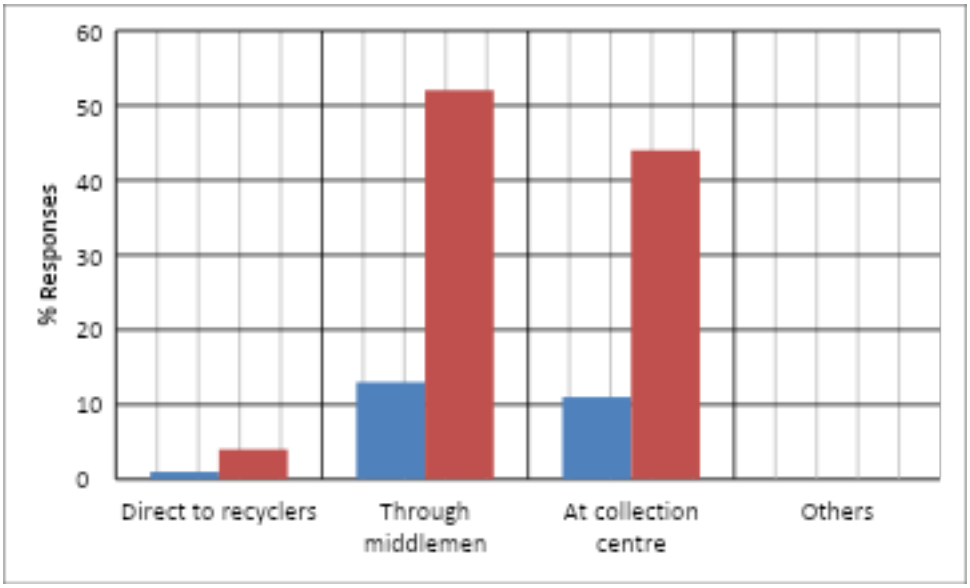


Fig. 62d: Sale arrangement for recovered materials in the FCT, Abuja

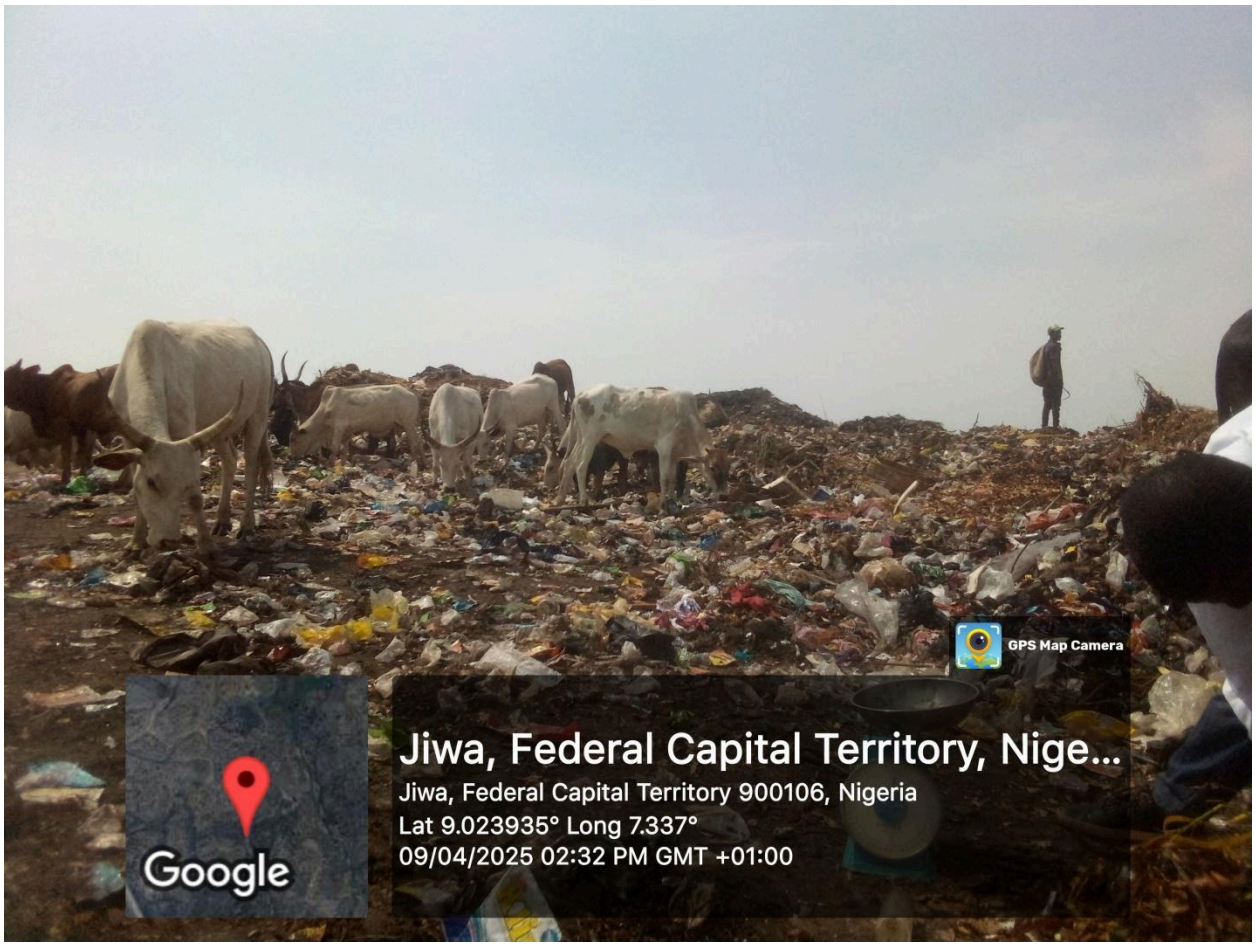


Fig. 64 Herders bring their cows to feed on decomposable waste at Goza dumpsite

Challenges Faced by Waste Pickers in Nigeria

Some of the challenges faced by waste pickers in the surveyed states and the FCT, Abuja are low proceeds from sale of recovered materials, poor working condition, lack of legal recognition and public harassment. The activities of waste pickers are often called "informal" because they operate outside the formal, regulated waste management systems, often lacking official permits/recognition, contracts, or consistent employment, and are typically involved in collecting and sorting recyclable materials. These informal workers, often living in extreme poverty, are key components in any waste management model, as they aid in recovery initiative, promote the reuse or resell plastics, textiles, aluminium and other valuable materials from waste. There are also the issues of public/social acceptance and exposure to health risks/occupational hazards associated with their operations (Figs 63 a-d).

Waste pickers use of Protective Gears

In Figs 64a-d, less than 35% of sampled waste pickers make use of protective gears such as gloves, masks, and boots. Others indicated that they some use such protective gears when they can afford them. The challenges faced by the scavengers in Nigeria are not unique to them alone, they are found among scavengers across the country and developing nations. Waste pickers are at the heart of the circular economy, where they play an essential role. To effectively integrate waste pickers in the proposed project - MAMRN, their status as an informal sector must be changed and their working conditions are to be improved and this requires policy solutions (Figs. 65a-d). In order to encourage informal waste pickers sorting in the country, there are needs for to create and enforce policies on source sorting, training of informal waste pickers, more awareness creation and better collection/sorting facility in public space (Figs 66 a-d).

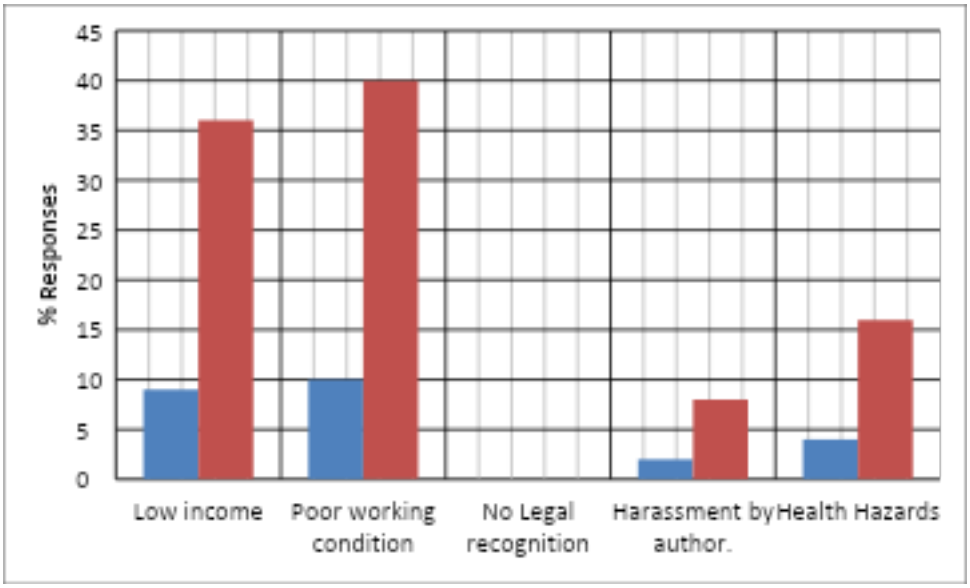


Fig. 63a: Challenges faced by Informal Waste Pickers in Benin City, Edo State

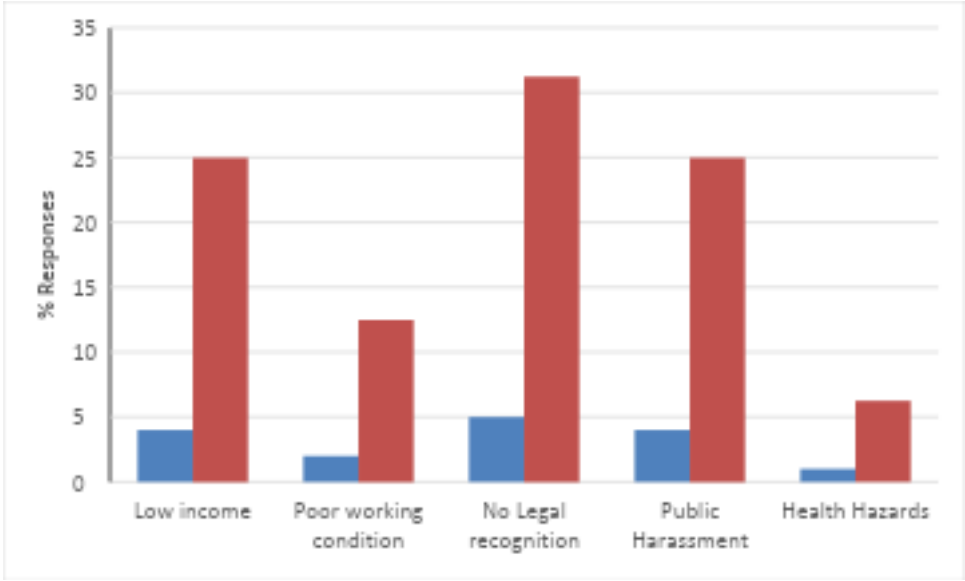


Fig. 63b: Challenges faced by Informal Waste Pickers in Epe, Lagos State

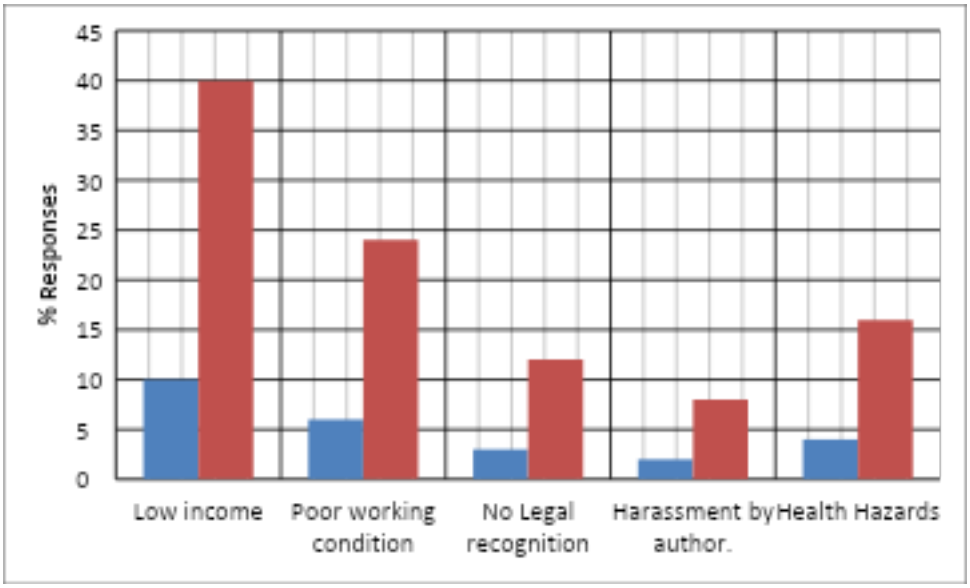


Fig. 63c: Challenges faced by Informal Waste Pickers in Jos Town, Plateau State

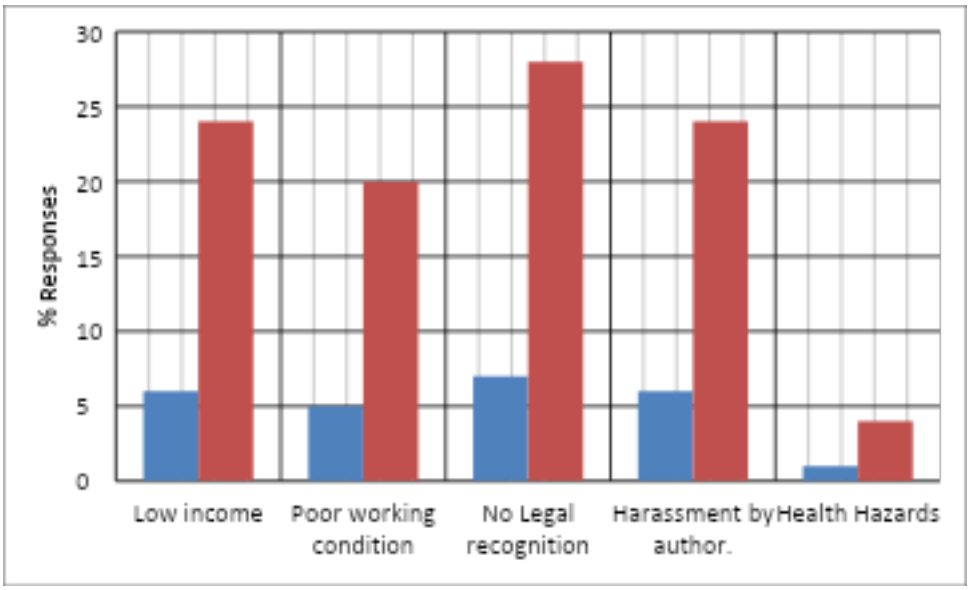


Fig. 63d: Challenges faced by Informal Waste Pickers in the FCT, Abuja

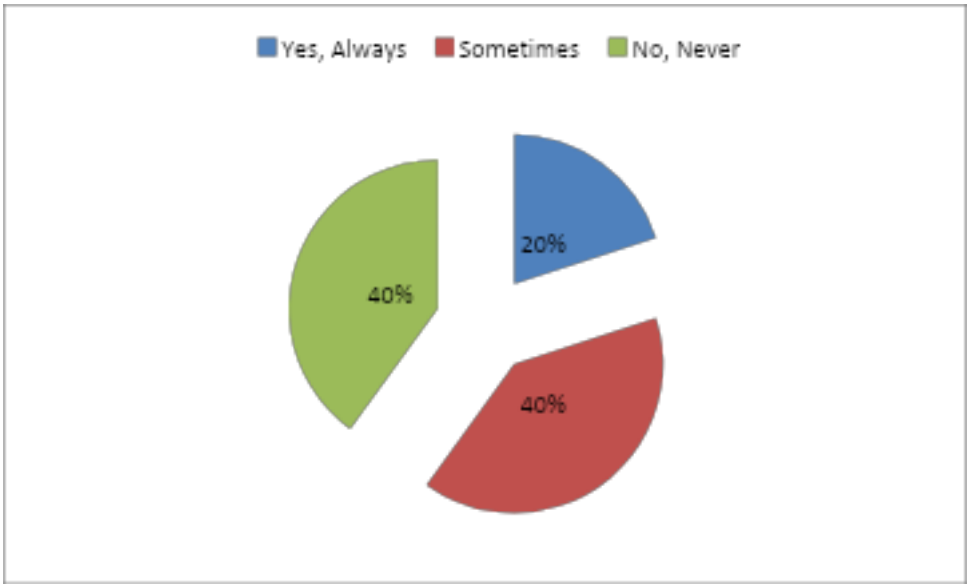


Fig. 64a: Informal Waste pickers use of protective gear during operation, in Benin City, Edo State

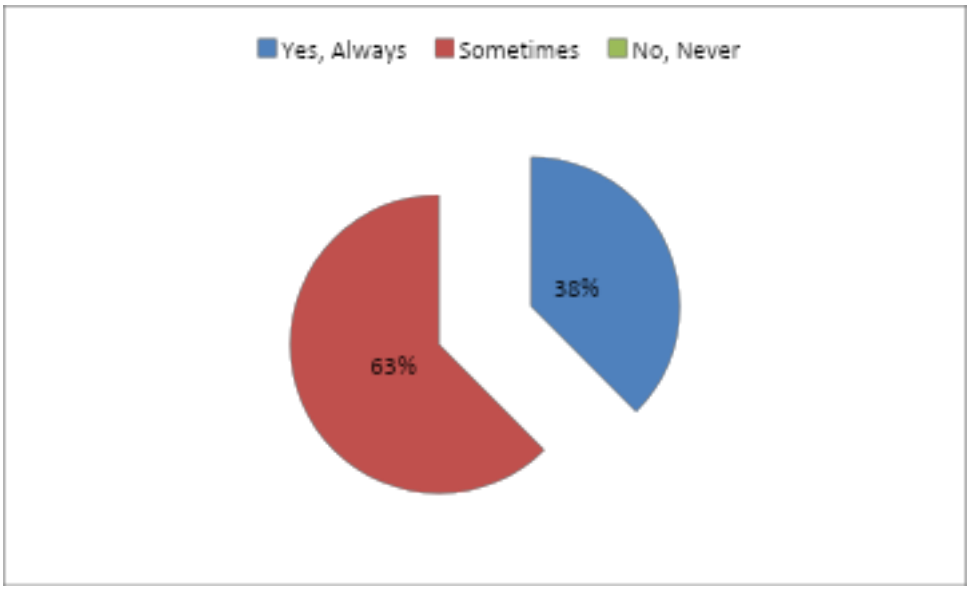


Fig. 64b: Informal Waste pickers, use is protective gear during operation, in Epe, Lagos State

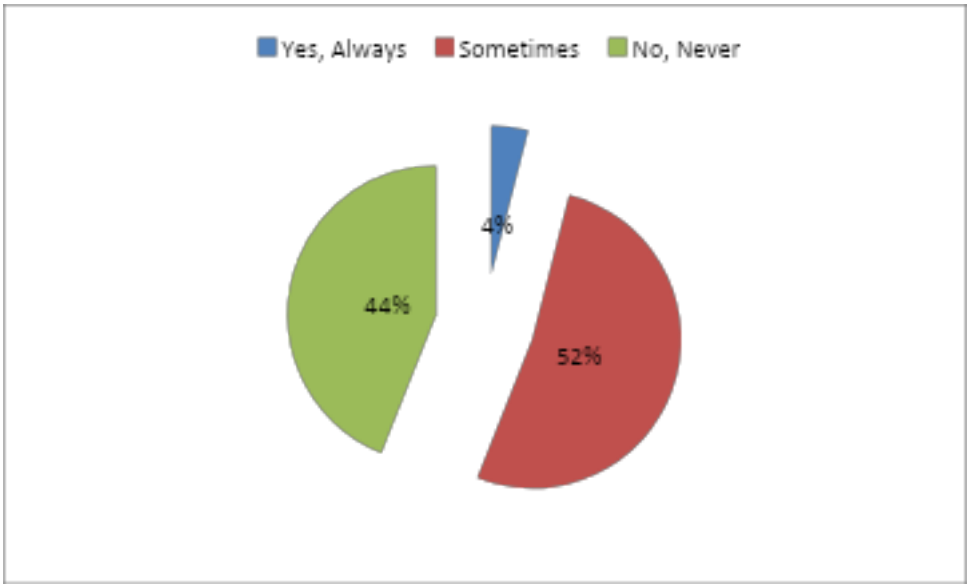


Fig. 64c: Informal Waste pickers use of protective gear during operation, in Jos Town, Plateau State

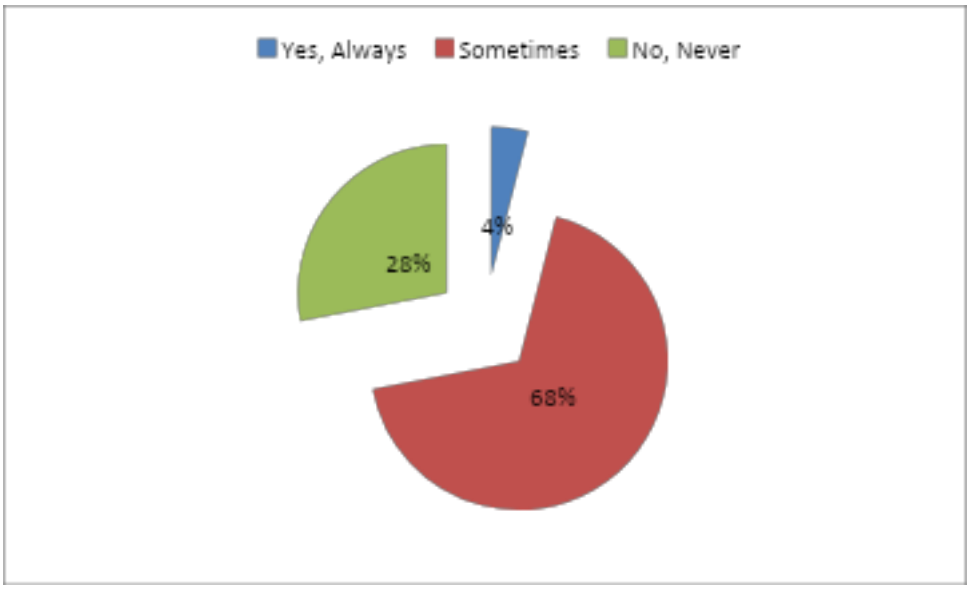


Fig. 64d: Informal Waste pickers use of protective gear during operation, in the FCT, Abuja

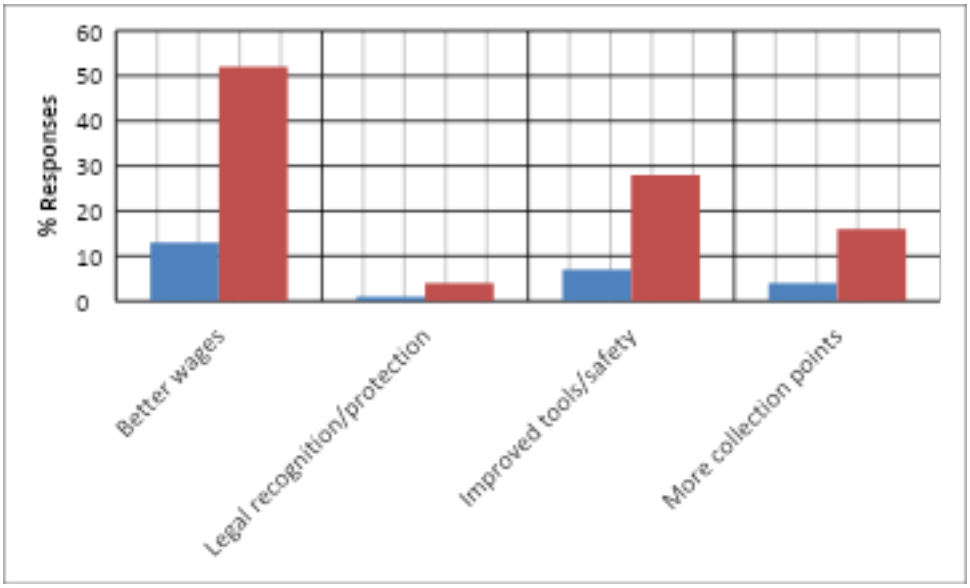


Fig. 65a: Perceived Factors that will enhance conditions of waste pickers in Benin City, Edo State

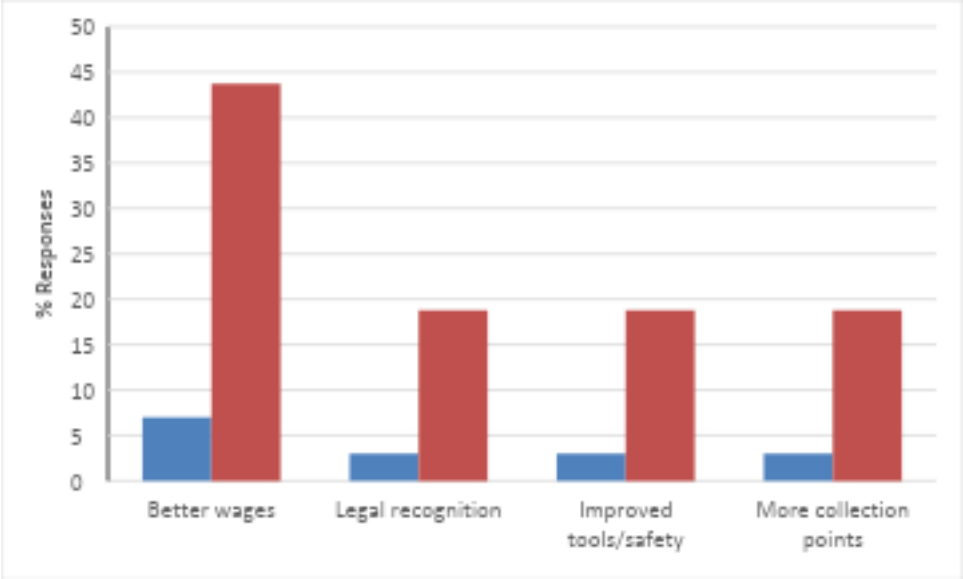


Fig. 65b: Perceived Factors that will enhance conditions of waste pickers in Epe, Lagos State

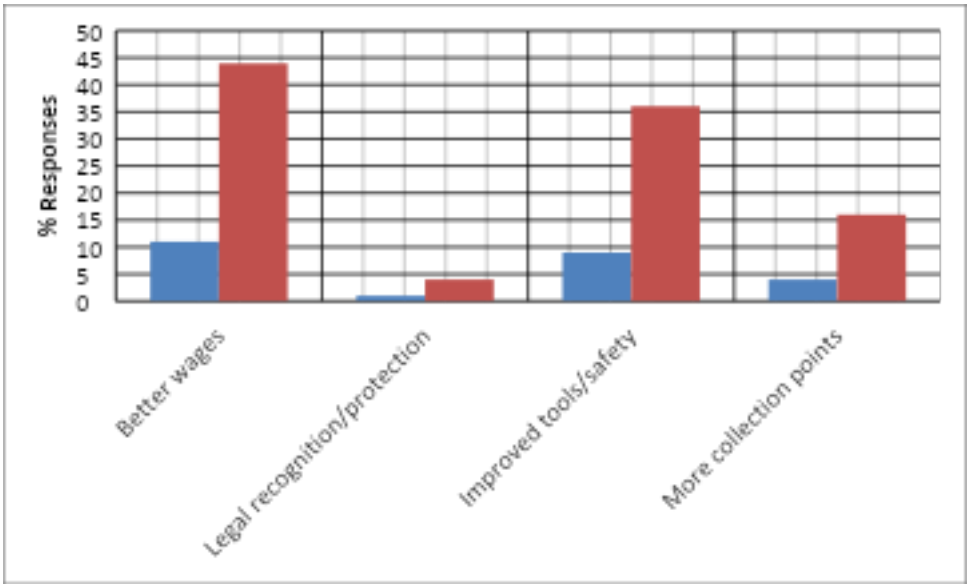


Fig. 65c: Perceived Factors that will enhance conditions of waste pickers in Jos Town, Plateau State

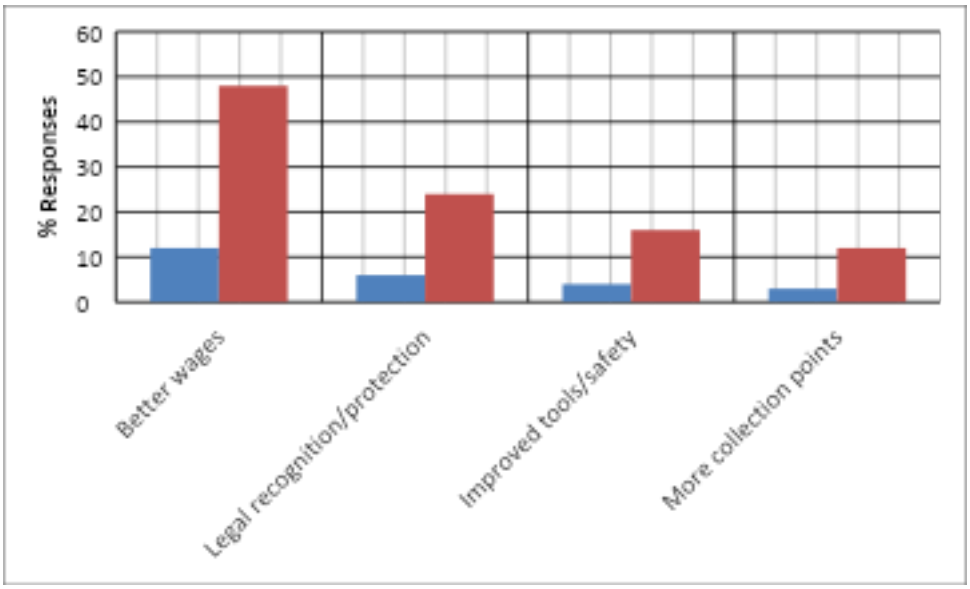


Fig. 65d: Perceived Factors that will enhance conditions of waste pickers in the FCT, Abuja

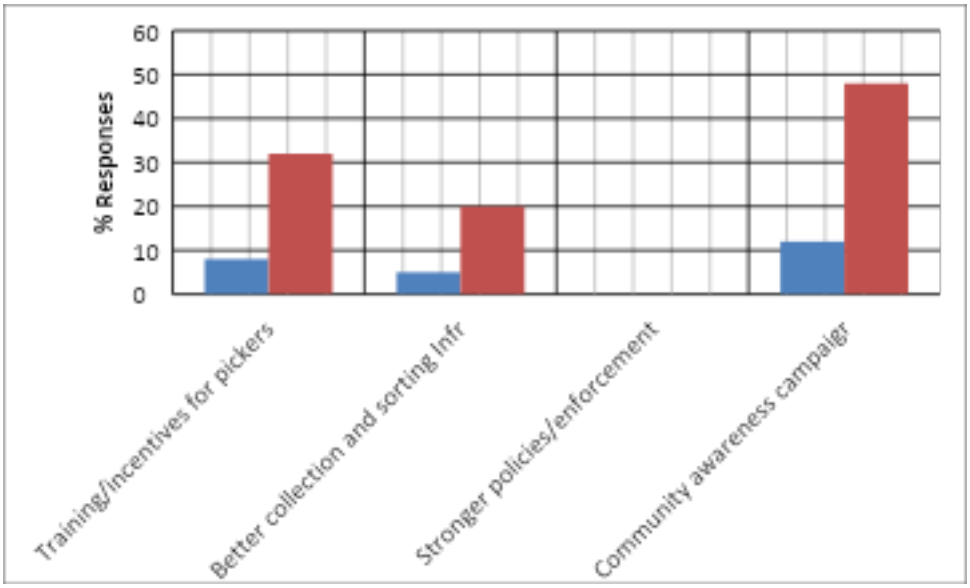


Fig. 66a: Ways to encourage informal waste pickers sorting in Benin City Edo State

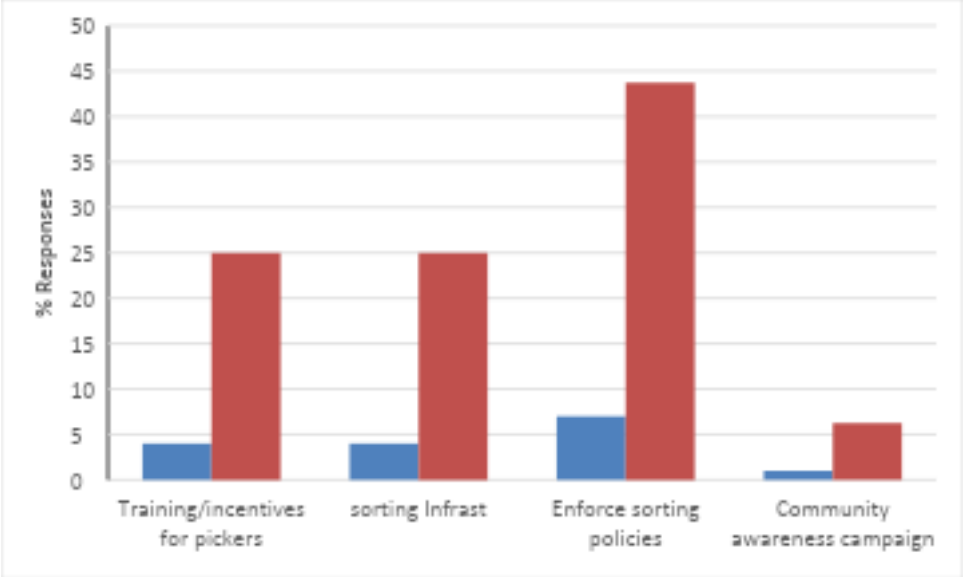


Fig. 66b: Ways to encourage informal waste pickers sorting in Epe, Lagos State

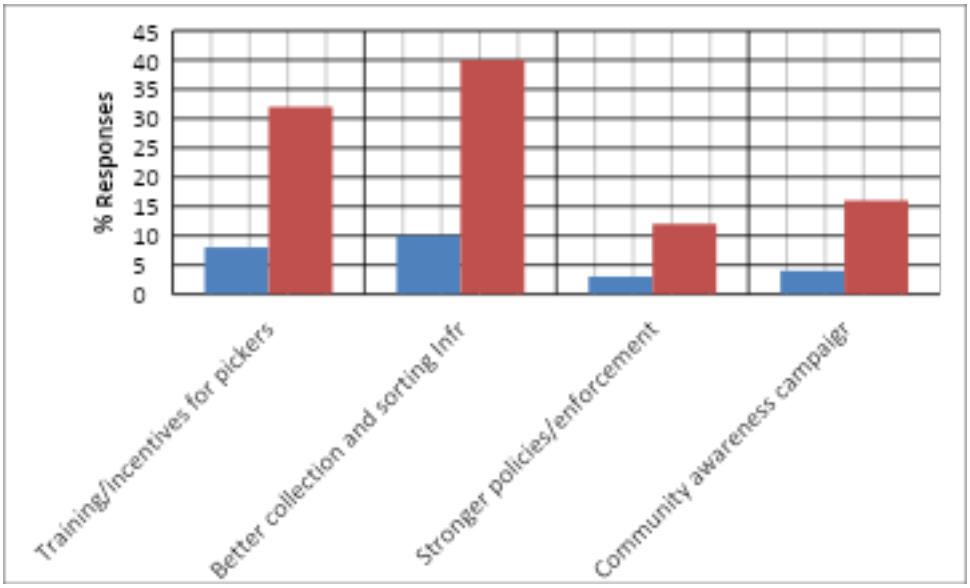


Fig. 66c: Ways to encourage informal waste pickers sorting in Jos Town, Plateau State

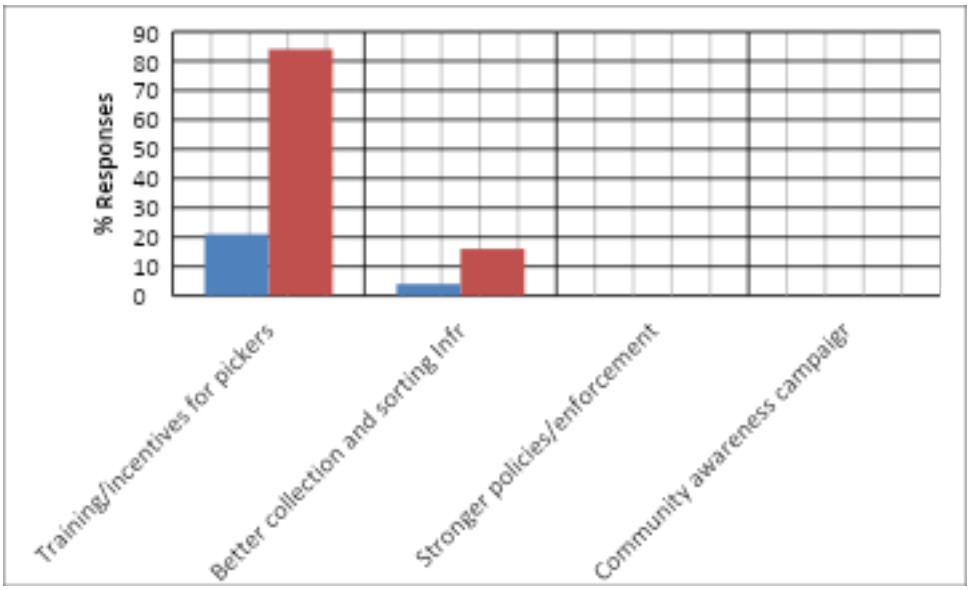


Fig. 66d: Ways to encourage informal waste pickers sorting in FCT, Abuja

12. POTENTIAL BENEFITS OF A MATERIAL RECOVERY FACILITY (MRF) IN NIGERIA

The establishment of a Material Recovery Facility (MRF) in Nigeria has the potential to bring about numerous socio-economic and environmental benefits. As Benin City, Jos Town, Lagos and FCT continue to grapple with rapid urbanization and increasing waste generation, an MRF can play a crucial role in enhancing waste management practices, reducing environmental degradation, and stimulating economic growth. This section explores key benefits in areas such

as employment generation, climate change mitigation, income generation, and agricultural support.

i. Employment Generation and Economic Growth

The development and operation of an MRF in Nigeria will create direct and indirect employment opportunities for a range of skill levels, contributing to poverty alleviation and economic empowerment in the region:

- Direct Employment: The facility will require a workforce for waste sorting, handling, data collection, and administrative roles. Jobs such as waste pickers, quality control personnel, and supervisors will be created, with an estimated 100–200 direct job in the initial phase.
- Indirect Employment: Beyond direct employment, the MRF will foster job creation across related sectors. Entrepreneurs can establish small businesses in waste transportation, maintenance services, and supply of processing equipment. Additionally, partnerships with private recyclers will open new economic opportunities for informal waste collectors.
- Skill Development and Training: Training programs in waste handling, sorting, recycling and composting technologies will empower local residents, enhancing their skill sets and employability. This capacity-building effort will be crucial for improving the overall efficiency of Nigeria's waste management ecosystem.

ii. Environmental Benefits

A fully operational MRF will significantly reduce the amount of waste sent to landfills, minimizing environmental pollution and preserving natural resources across the country:

- Reduction of Landfill Waste: By diverting recyclable materials (plastic, paper, metal, glass) from landfills, the MRF will help reduce the amount of waste sent to landfills particularly Landfills across the country.
- Mitigation of Illegal Dumping: Proper waste recovery reduces illegal dumping in waterways and public spaces, curbing flood risks and improving overall cleanliness in Nigeria Cities.

- ❖ Reduction in Plastic Pollution: Nigeria Cities generates millions of plastic bottles and sachets daily, much of which ends up in oceans and waterways. The MRF will recover plastics for recycling, reducing marine pollution and protecting aquatic ecosystems.
- ❖ Cleaner Communities: Enhanced waste management practices will improve community hygiene, reducing the prevalence of vector-borne diseases like malaria and cholera associated with poor sanitation.

iii. Climate Change Mitigation

MRFs are pivotal in mitigating climate change by reducing greenhouse gas (GHG) emissions associated with waste decomposition and incineration:

- ❖ Methane Reduction: Organic waste in landfills produces methane (CH_4), a potent greenhouse gas. By diverting organic waste from landfills into composting, the MRF will significantly cut methane emissions.
- ❖ Carbon Footprint Reduction: Recycling materials like plastic and aluminium requires far less energy than producing new products from virgin materials. The MRF will lower carbon dioxide (CO_2) emissions by promoting circular economy practices.

iv. Increased Income Levels and Value Creation

The MRF will transform waste into valuable resources, creating economic incentives for both individuals and businesses:

- ❖ Incentives for Waste Collectors: Informal waste pickers and scavengers can formalize their activities by selling sorted recyclables directly to the MRF, increasing their daily earnings.
- ❖ Organic Waste Valorisation: Organic waste will be processed into compost or organic fertilizers, giving farmers access to affordable soil enhancers. This value chain will stimulate the local economy, encouraging small-scale farmers to diversify their income streams by selling organic waste to the MRF.
- ❖ Recycling Market Growth: By supplying industries with recovered materials, the MRF will strengthen local recycling markets and promote Edo, Plateau, Lagos State and the FCT, Abuja as hubs for sustainable production.

v. Benefits to Farmers and Agriculture

Farmers in Epe and neighbouring communities will benefit from improved access to organic fertilizers and compost generated by the MRF:

- Improved Soil Fertility: Organic compost enriches soil structure, boosts moisture retention, and enhances crop yields, reducing farmers' reliance on expensive synthetic fertilizers.
- Cost Reduction: The availability of locally produced compost will lower input costs for farmers, improving their profit margins and making agriculture more sustainable.
- Support for Urban Agriculture: Epe is home to many smallholder farmers who will benefit from initiatives promoting organic farming practices and climate-resilient agriculture through the use of eco-friendly fertilizers.

vi. Community Development and Awareness

The MRF will serve as a platform for community engagement and environmental education:

- Waste Management Awareness: Community programs will educate residents on waste separation, recycling, and sustainable consumption practices.
- School Programs: Schools can partner with the MRF for eco-education programs, fostering a sense of environmental stewardship among students.
- Community Ownership: Local residents will feel a sense of ownership over the facility, resulting in improved cooperation with waste management authorities and higher compliance rates in household waste segregation.

13. POTENTIAL SOCIAL ACCEPTANCE AND COMMUNITY WILLINGNESS TO SUSTAIN THE MRF INITIATIVE IN NIGERIA

The establishment of a Material Recovery Facility (MRF) in Benin City, Epe town, Jos Town and the FCT has the potential to transform waste management practices in these states. However, the long-term success of this initiative hinges on the social acceptance and willingness of the local communities and key stakeholders to support and sustain the project. Social acceptance encompasses the community's perception, engagement, and support for the initiative, while

sustainability relies on active participation, education, and long-term benefits for local residents. This section explores the key factors influencing social acceptance, the community's willingness to sustain the initiative, and strategies to foster long-term support.

i. Understanding Community Perception and Awareness

Community perception plays a pivotal role in determining the success of any public infrastructure project. In Nigeria, several factors will influence social acceptance of MRF Project:

- Awareness of Waste Management Challenges: Edo, Plateau, Lagos and FCT, Abuja, like many parts of country, grapples with poor waste management, leading to blocked drainage systems, environmental pollution, and health hazards. Residents are increasingly aware of these issues and may view the MRF as a solution to persistent waste-related challenges.
- Perceived Environmental Benefits: The community is likely to support initiatives that promise a cleaner environment, reduced odour from dumpsites, and a decline in open burning of waste — a common practice that contributes to air pollution.
- Trust in Government and Institutions: The level of trust between the community and government institutions such as state and municipal waste management authorities/Board/Agencies will significantly influences acceptance. Past experiences of abandoned projects or inadequate public service delivery may create scepticism, necessitating a transparent and inclusive approach in implementing the MRF.

ii. Socio-Economic Incentives and Community Buy-In

For long-term community willingness, the MRF must offer tangible socio-economic benefits that improve livelihoods:

- Job Creation and Livelihoods: The MRF will create direct employment opportunities in waste collection, sorting, processing, and facility management. Indirect jobs will arise through waste transportation, recycling businesses, and local markets for recovered materials. Community members, particularly youth and women, are likely to support the initiative if it offers stable employment and skills development.

- ❖ Income Generation from Recyclables: Informal waste pickers, currently earning from scavenging activities, could transition into formal employment with better wages. Additionally, community members could earn income by selling sorted recyclables directly to the MRF.
- ❖ Farmers' Access to Organic Fertilizer: Compost produced from organic waste will provide affordable fertilizers to local farmers, improving soil fertility and crop yields. Farmers' willingness to support the project will increase if they perceive the MRF as a source of cost-effective agricultural inputs.

iii. Cultural and Behavioural Factors

Shifting waste disposal habits and encouraging waste segregation at the household level will be critical to sustaining the MRF:

- ❖ Community Norms on Waste Disposal: In many parts of Nigeria, disposing of waste in open dumps or water bodies is still common practice. The MRF's success will depend on changing these habits through awareness campaigns and incentives.
- ❖ Integration with Traditional Structures: Involving community leaders, chiefs, and religious institutions can boost acceptance. Traditional leaders are respected figures and can help mobilize community support while ensuring local values align with the project.

iv. Educational Campaigns and Capacity Building

Education plays a key role in ensuring the community understands the long-term benefits of the MRF:

- ❖ Awareness Campaigns: Waste Management Authorities and local authorities should conduct awareness campaigns on the importance of waste segregation, recycling, and environmental sustainability. Engaging schools, religious groups, and community associations will ensure the message reaches diverse demographics.
- ❖ Skill Development: Providing training programs in waste sorting, recycling techniques and compost production will empower the local workforce, fostering a sense of ownership and long-term commitment to the facility.

v. Community Participation and Ownership

For the MRF to be sustainable, the community must feel ownership of the project:

- Community Zero Waste Ambassadors (ZeWA): Establishing ZeWA made up of community members, local businesses, farmers, and youth leaders will ensure that residents have a voice in the facility's management and decision-making processes.
- Feedback Mechanisms: Creating accessible feedback mechanisms — such as suggestion boxes, town hall meetings, or digital platforms — will allow residents to express concerns and propose solutions, fostering transparency and trust.

vi. Addressing Potential Barriers to Acceptance

While the benefits of the MRF are clear, some barriers could impede community acceptance:

- Fear of Displacement: Some residents may fear that the construction of the MRF could result in displacement from ancestral lands or businesses. Transparency in land acquisition processes is crucial.
- Misinformation and Rumours: Misconceptions about the health risks associated with waste processing facilities may arise. Addressing misinformation through community engagement sessions and providing accurate information will be essential.
- Concerns about Odour and Pollution: Residents may be wary of unpleasant odours and increased pollution levels. Proper facility design, including odour control systems, leachate management, and green buffers (trees and vegetation), can help alleviate these concerns.

vii. Long-Term Sustainability and Community Ownership

The long-term sustainability of the MRF depends on embedding it within the social fabric of sampled cities:

- Incentive Programs: Introducing incentives such as reduced waste collection fees for compliant households and rewards for high recyclers will motivate participation.
- Public-Private Partnerships (PPPs): Collaborating with private companies for technology transfer and funding will ensure the facility's financial sustainability while creating new market opportunities.

- ❖ Monitoring and Evaluation: Regular assessment of the MRF's performance, coupled with community feedback loops, will ensure the facility continuously evolves to meet the community's needs Table 10.

Table 10: Indicator Table showing expected project benefits targets

Indicator Category	Baseline Indicator	Unit of Measurement	Baseline Value	Target Value @ End of Project	Data Collection Method	Frequency of Measurement
Farmers' Composting and Manure Use	Percentage of farmers currently using compost manure	% of farmers using compost manure	52%	70%	Farmer surveys, interviews	Baseline & Annually
	Reduction in chemical fertilizer use	% decrease in petroleum-based fertilizer use	52%	60% reduction	Surveys, farm input purchase records	Baseline & Annually
	Awareness level of farmers on the benefits of compost manure	% of farmers with improved knowledge of composting benefits	0	80%	Pre and post-training assessments, focus groups	Baseline & Post-training
	Percentage of farmers interested in adopting compost manure	% of farmers willing to switch	80%	100%	KII interviews	Baseline & Mid-term
Local Government Employees' Practices on Composting	Number of local government staff trained in composting and waste management	Number of employees trained	0 (Before training)	100% trained	Training records, attendance sheets	Baseline & Post-training
	Existence of composting policies or guidelines in local government regulations	Yes/No	Yes	Yes with a verified policy document	Policy document review	Baseline & Endline
	Current waste management strategy of local authorities	Description of waste practices	Yes	Sustainable composting strategy developed	Interviews with officials, policy reviews	Baseline & Annually

Waste Management and Waste Pickers	Current waste diversion rate from landfills	Tons of waste diverted per week	0	5 tons per week	MRF Reports	Baseline & Quarterly
	Percentage of waste currently being composted	% of total waste composted	12.5%	80%	MRF facility logs	Baseline & Bi-Annually
	Current capacity and efficiency of waste pickers in sorting waste	% of waste correctly sorted	43.75%	75%	Observations, performance assessments	Baseline & Annually
	Awareness level of waste pickers on composting practices	% of waste pickers demonstrating improved awareness of composting	0	70%	Surveys, focus groups, Training assessments	Baseline & Mid-term
Methane Emissions and Environmental Impact	Estimated methane emissions from organic waste decomposition	Max Metric tons of methane emitted	15,578.5 Tonnes	30% reduction	Environmental impact studies	Baseline & Endline
	Percentage of organic waste ending up in landfills	Aver. % of organic waste in landfill waste streams	60.0%	50% reduction	Landfill data, waste audits	Baseline & Annually
Community Awareness and Engagement	Percentage of community members aware of methane reduction and zero waste practices	% of population with awareness	68%	75%	Surveys, community engagement sessions	Baseline & Mid-term
	Number of community members participating in waste segregation and composting activities	Number of participants	420	>700	Attendance records, observation	Baseline & Annually

14. PROPOSED MATERIAL RECOVERY MODEL IN NIGERIA

The proposed Material recovery model will focuses on extracting value and resources from waste materials, aiming to reduce landfill waste and promote a circular economy by reusing, recycling, or transforming waste into compost manure. This material recovery model is built based on the findings of the present survey. Components of the model include;

- Community which comprise households, fruits sellers, farmers who serve as organic wastes generators in the model
- Waste pickers/waste collectors who will serve as middlemen between waste generators and Material recovery facility/investors
- State government and Local government instruments which will provide policy and administrative framework to promote source sorting and provision of platforms for waste-cash plan/incentives and integration of informal waste pickers into the state waste management frameworks.
- MRF: transform waste to organic mature, create employment and state-wide development

Model appendage

- Stakeholders training (state and non-state actors)
- Public education, public campaigns,
- Composting facilities
- Policy framework

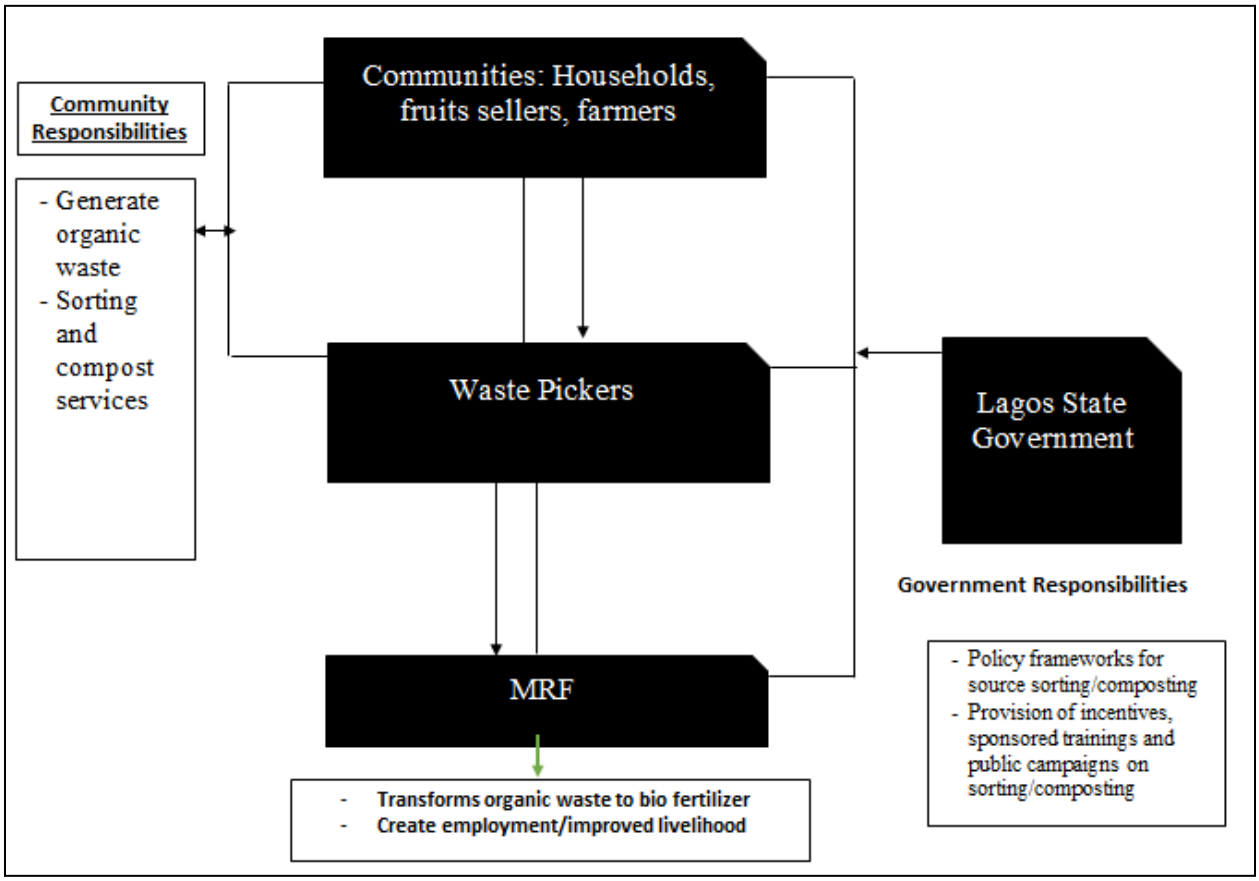


Fig. 67: Proposed Material Recovery Model

15. CONCLUSION

The baseline study carried out in Benin City, Edo Stat, Epe, Lagos State, Jos town, Plateau and the FCT, Abuja, highlights a pressing need for effective and sustainable waste management practices. These are essential to curb methane emissions and tackle the increasing environmental and public health issues stemming from poor waste disposal systems. Every day, Nigeria cities produces around 13,000 to 15,000 metric tonnes of solid waste, but only about 40% of that is collected efficiently, leaving a large amount unaccounted for. The unchecked build-up of organic waste in open dumpsites not only harms the environment but also worsens climate change effects through methane emissions, air pollution, and increased flooding risks.

The study points out that, while there are waste management structures in place, they are not enough to handle the current and future levels of waste generation. Some of the main challenges include inadequate infrastructure, limited collection coverage, poor waste segregation practices, and a lack of enforcement of waste management regulations. Additionally, the informal sector plays a significant role in waste management but often lacks the necessary support, resulting in unsafe working conditions for waste pickers and lost opportunities for effective material recovery and recycling.

The study also emphasizes the urgent need for community-driven initiatives to support existing government efforts. For instance, setting up a Material Recovery Facility (MRF) in Nigeria could be a game-changer, improving waste segregation, processing, and recycling, which would ultimately reduce the amount of waste sent to landfills/dumpsites. Furthermore, promoting zero-waste farming practices can provide a dual advantage: it diverts organic waste from dumpsites while boosting agricultural productivity through compost use, which in turn helps lower methane emissions from both waste and agriculture.

Community engagement will become a key player in the success of these initiatives. By empowering local stakeholders through programs like the Zero Waste Ambassadors (ZeWA) and the Zero Waste Farmers Network, the project can spark grassroots action, boost public awareness, and nurture a culture of sustainability. Additionally, pushing for policy changes that

adopts composting and organic waste diversion instead of relying on incineration is vital for aligning local efforts with global climate action goals.

In summary, the findings highlight that a well-rounded approach; one that includes developing infrastructure, engaging the community, reforming policies, and on-going monitoring is essential for transforming waste management practices in Nigeria. These strategies can lead the way toward a more sustainable and resilient waste management system, setting an example for other states in Nigeria that's grappling with similar issues.

16. RECOMMENDATIONS

From the baseline research conducted, the affected States and the FCT, Abuja can do more significant strides toward achieving sustainable waste management, reducing methane emissions, and fostering community resilience against climate change impacts. The integration of infrastructure development, community-driven initiatives, policy advocacy, and continuous monitoring will be key to ensuring the long-term success and sustainability of these interventions. Find below recommendations to ensure the MAMRN intervention is successful in Lagos State

1. **Strengthening Infrastructure and Logistics:**
    - Establish a well-equipped Material Recovery Facility (MRF) to facilitate proper waste segregation, recycling, and composting.
    - Expand the waste collection network by increasing the number of Private Sector Participants (PSPs) and providing them with modern collection vehicles.
    - Implement digital tracking systems for waste collection vehicles to ensure timely collection and reduce illegal dumping.
    - Develop transfer stations to reduce transportation distances and improve logistics efficiency.
2. **Community Participation and Capacity Building:**
    - Involve local communities from the project's inception through participatory planning sessions to build a sense of ownership.

- Conduct regular training sessions for waste pickers, farmers, and local authorities on waste segregation, composting, and organic farming.
- Establish Zero Waste Ambassadors (ZeWA) to lead awareness campaigns and act as sustainability champions.

3. **Policy and Institutional Support:**
   - Advocate for local government policies that formalize the integration of waste pickers into the formal waste management system.
   - Collaborate with policymakers to develop clear guidelines for organic waste diversion and composting practices.
   - Strengthen enforcement of waste management regulations and introduce incentives for communities and businesses adopting sustainable practices.
4. **Promoting Sustainable Agriculture:**
   - Launch the "My Zero Waste Farm Project" to train farmers on compost use as a sustainable alternative to chemical fertilizers.
   - Establish a Zero Waste Farmers Network to facilitate peer learning, promote agroecology practices, and amplify advocacy efforts.
   - Support farmers in adopting composting techniques and using compost to enhance soil fertility and boost crop productivity.
5. **Public Awareness and Advocacy:**
   - Organize regular public awareness campaigns, leveraging local media and community radio to promote zero-waste practices.
   - Implement school-based programs to educate students on waste reduction, recycling, and environmental stewardship.
   - Establish a Waste Parliament to provide a platform for policymakers, local authorities, and community members to discuss sustainable waste management practices.

6. **Monitoring, Evaluation, and Learning:**
    - Develop a robust monitoring and evaluation (M&E) framework to track progress, identify challenges, and adapt strategies in real-time.
    - Conduct regular impact assessments to measure the effectiveness of interventions and capture lessons learned.
    - Facilitate knowledge-sharing sessions and cross-learning opportunities with similar projects to enhance implementation success.
7. **Financial Sustainability:**
    - Diversify funding sources by engaging private sector partners, development agencies, and community-based financing mechanisms.
    - Introduce a community-based financing model that encourages households and businesses to contribute to waste collection and recycling services.

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APPENDIX A:

Farmer's questionnaire

Dear Respondent,

We are a team of researchers from the Centre for Earth Works Development (CFEW), Sustainable Environment Development Initiative (SEDI) and Green Knowledge Foundation and Community Development Advocacy Foundation (CODAF). We are conducting a study on **MULTI-SOLVING ACTION FOR METHANE REDUCTION IN NIGERIA (Lagos, Abuja, Jos and Benin).** We assure you that your participation and the answers you provide in this questionnaire will be kept confidential. We therefore urge you to answer the questions below as honestly as possible.

Thanks in advance for your cooperation.

Sincerely,

Instruction: kindly tick the boxes that best expresses your responses or fill out the blank spaces as the case may be.

S/N	A: Background Characteristics	Responses	Code
01	What is your age?	Actual	.....
02	What is your gender?	Male Female	☐ 1 ☐ 2
03	What is your marital status?	Married Never married Divorced Others	☐ 1 ☐ 2 ☐ 3 ☐ 4
04	What is your highest educational qualification?	School Certificate and below B.Sc./HND Masters Ph.D	☐ 1 ☐ 2 ☐ 3 ☐ 4
05	What is your ethnic group?	Actual	
06	What is monthly income level	Less than N100,000 N100,001 – N200,000 N200,001 – N300,000 Above N3000,000	☐ 1 ☐ 2 ☐ 3 ☐ 4
07	How long have you been farming?	Less than 3years 4- 6years	☐ 1 ☐ 2

		7-9 years 9 years and above	☐ 3 ☐ 4
09	Types of crops ?	Actual	……..

Section B:

1. Do you use compost manure on your farm? (Yes/No)
2. If no, why do you not use compost manure? (Select all that apply: It is expensive / I don't know how to use it / I cannot find it / Other - please specify_____)
3. What type of fertilizers do you use on your farm? (Chemical fertilizers / Organic compost / Both / None)
4. How well do you understand composting and its benefits? (1 = I do not know anything /2= I know little about it / 3= I have some knowledge about it / 4 = I know everything about it)
5. Would you be willing to switch to compost manure if support is provided? (Yes/No/Maybe)
6. Do you think using chemical fertilizers can cause environmental problems? (1. Strongly agree /2. Agree / 3. Neutral /4. Disagree /5. Strongly disagree)
7. Have you heard of bio-fertilizers, and do you know what they are? (1. Strongly agree /2. Agree/ 3. Neutral /4. Disagree / 5. Strongly disagree)
8. Would you be willing to use and pay for bio-fertilizers if they were available? (1. Strongly agree /2. Agree /3. Neutral / 4. Disagree/ 5. Strongly disagree)
9. What would encourage you to support and participate in waste composting? (Financial incentives or subsidies /Training and awareness campaigns / Access to composting bins / Government regulations enforcing composting)
10. How do you dispose of organic waste from farming? 1) Burn it [ ]/ 2) Use it for composting/ 3 Leave it on the farm/ 4 Dispose of it in regular waste
11. What benefits do you see in using compost manure? 1) Improves soil quality [ ]/ 2. Reduces chemical fertilizer costs [ ]/ 3) Helps manage farm waste effectively [ ]/ 4) No benefits seen [ ].
12. What support would encourage you to start composting? 1) Training on composting [ ] 2) Free or subsidized composting tools [ ]/ 3) Government incentives [ ]/ 4) None of the above [ ]
13. Do you try to reduce waste and reuse materials on your farm? 1) Yes, always [ ]/ 2) Sometimes [ ]/ 3) No
14. What makes it difficult for you to reduce and reuse waste on your farm? 1) Lack of knowledge [ ]2) Lack of resources [ ] 3) No perceived benefit [ ]4) Other……..
15. What are your reasons for using or avoiding chemical fertilizers? 1) Improves crop yield [ ]/2) Too expensive [ ]/ 3) Harmful to the environment [ ]/ 4) Lack of access [ ]

16. How does the government support farmers and waste pickers in waste management? 1) Provides training and awareness [ ]/ 2) Provides financial incentives [ ]/ 3) Provides tools and equipment [ ]/ 4) No government support [ ]

17. What do you think about reducing and reusing waste instead of turning waste into energy (**MAMRN**)? 1) Very good idea [ ]/ 2) Somewhat good idea [ ]/ 3) Not sure of its benefits [ ]/ 4) won't make any impact [ ]

For Local Government Employees and Waste Managers

Dear Respondent,

We are a team of researchers from the Centre for Earth Works Development (CFEW), Sustainable Environment Development Initiative (SEDI) and Green Knowledge Foundation and Community Development Advocacy Foundation (CODAF). We are conducting a study on **MULTI-SOLVING ACTION FOR METHANE REDUCTION IN NIGERIA (Lagos, Abuja, Jos and Benin).** We assure you that your participation and the answers you provide in this questionnaire will be kept confidential. We therefore urge you to answer the questions below as honestly as possible.

Thanks in advance for your cooperation.

Sincerely,

Instruction: kindly tick the boxes that best expresses your responses or fill out the blank spaces as the case may be.

S/N	A: Background Characteristics	Responses	Code
01	What is your age?	Actual	.....
02	What is your gender?	Male Female	☐ 1 ☐ 2
03	What is your marital status?	Married Never married Divorced Others	☐ 1 ☐ 2 ☐ 3 ☐ 4
04	What is your highest educational qualification?	School Certificate and below B.Sc./HND Masters Ph.D	☐ 1 ☐ 2 ☐ 3 ☐ 4
05	What is your ethnic group?	Actual	
06	What is monthly income level	Less than N100,000 N100,001 – N200,000 N200,001 – N300,000 Above N3000,000	☐ 1 ☐ 2 ☐ 3 ☐ 4
07	How long have you been in working with the State government?	Less than 3years 4- 6years 7-9 years 9 years and above	☐ 1 ☐ 2 ☐ 3 ☐ 4

08	For how long (in years) have you been working in this LGA	Less than 3years 4- 6years 7-9 years 9 years and above	☐ 1 ☐ 2 ☐ 3 ☐ 4

Section B: Market Waste Data (Thick where appropriate) (General)

1. How is waste collection structured at the local government level?
    a. Regularly scheduled collections [ ]
    b. Sometimes Irregular collections [ ]
    c. Inadequate formal collection coverage [ ]
    d. Community-managed collection [ ]
2. Are there penalties for improper waste disposal?
    a. Yes, strict penalties exist [ ]
    b. Some penalties, but not enforced [ ]
    c. No penalties exist [ ]
    d. Don't know [ ]
3. What improvements are needed in waste management policies?
    a. Better enforcement of existing laws [ ]
    b. More funding for waste management [ ]
    c. Greater community involvement [ ]
    d. No improvements needed [ ]
4. Are there plans to set up composting centers or encourage farmers to use compost?
    a. Yes, there are active plans [ ]
    b. There are discussions but no concrete plans[ ]
    c. No plans exist [ ]
    d. Don't know [ ]
5. How can reusing of waste/composting methane reduction be sustained in your community?
    a. Conducting awareness campaigns [ ]
    b. Providing financial incentives for composting [ ]
    c. Partnering with community groups [ ]
    d. No action needed [ ]
6. What strategies have been most effective in improving waste sorting efficiency?

a. Training and incentives for waste pickers and managers [ ]
b. Better waste collection and sorting infrastructure [ ]
c. Stronger policies and enforcement on waste separation [ ]
d. Community awareness campaigns and engagement [ ]

Section C: Policy and Regulatory Review

7. Are there laws that support composting and reducing methane gas in Lagos State? (Yes/No)
8. Do any policies encourage farmers and households to use compost instead of chemical fertilizers? (Yes/No)
9. Are waste pickers recognized legally in any government policies? (Yes/No)

Household questionnaire

Dear Respondent,

We are a team of researchers from the Centre for Earth Works Development (CFEW), Sustainable Environment Development Initiative (SEDI) and Green Knowledge Foundation and Community Development Advocacy Foundation (CODAF). We are conducting a study on **MULTI-SOLVING ACTION FOR METHANE REDUCTION IN NIGERIA (Lagos, Abuja, Jos and Benin).** We assure you that your participation and the answers you provide in this questionnaire will be kept confidential. We therefore urge you to answer the questions below as honestly as possible.

Thanks in advance for your cooperation.

Sincerely,

Instruction: kindly tick the boxes that best expresses your responses or fill out the blank spaces as the case may be.

S/N	A: Background Characteristics	Responses	Code
01	What is your age?	Actual	.....
02	What is your gender?	Male Female	☐ 1 ☐ 2
03	What is your marital status?	Married Never married Divorced Others	☐ 1 ☐ 2 ☐ 3 ☐ 4
04	What is your highest educational qualification?	School Certificate and below B.Sc./HND Masters Ph.D	☐ 1 ☐ 2 ☐ 3 ☐ 4
05	What is your ethnic group?	Actual	
06	What is monthly income level	Less than N100,000 N100,001 – N200,000 N200,001 – N300,000 Above N3000,000	☐ 1 ☐ 2 ☐ 3 ☐ 4
07	What is your occupation?	Public service (Govt) Private institution Public service/Personal busi Farming	☐ 1 ☐ 2 ☐ 3 ☐ 4

08	For how long (in years) have you been living here	Less than 3years 4- 6years 7-9 years 9 years and above	☐ 1 ☐ 2 ☐ 3 ☐ 4
09	Number of persons, including children living in your home	1 – 3 4 – 6 More than 6	☐ 1 ☐ 2 ☐ 3

Section B: Waste generation and Waste Management

1. Common types of waste generated at home? a. Organic waste [ ], b. plastics/rubber, [ ], c. metals [ ], d. wood/furniture [ ], e. paper, [ ], f, glass [ ]
2. Method of waste disposal
   a. Private Waste vendor [ ]/ b. Government provided waste bins [ ]/ c. Disposal of in open space and unused land [ ]/ d. Burning [ ]/e. Composting [ ]
3. Do you practice source sorting? a. Yes [ ]/ b. No [ ]
4. If yes to question Number 2, do you practice complete separation? a. Partial separation [ ]/ b. Complete separation [ ]
5. If no to question number 2, what are your challenges? a. Lack of knowledge [ ]/ b. No access to composting facility [ ]/ c. Lack of bins [ ]/ d. No government support [ ]/ e. No framework for source separation [ ]
6. How often do you compost your household organic waste? a. Always [ ]/ b. Sometimes [ ] /c Never [ ]
7. How often do you turn your food and plant waste into compost? a. Always [ ]/ b. Sometimes [ ]/ c. Never [ ]
8. What factors in your opinion will affect sustainable waste management including sorting and composing at household level? a. Income level [ ]/ b. Educational level [ ]/c Age [ ]/ d. Sex [ ]/ d. Government support/training [ ]
9. Are you are aware organic waste produces methane gas, which affects the environment? a. Yes [ ]/ b. No [ ]
10. What are the biggest problems you face in managing waste in your area? a. No waste collection service [ ]/ b. No waste bins [ ]/ c. No composting facility [ ]/ d. Other - please specify [ ]

a. Do you think changes in weather, such as more heat, more rain, or floods, are caused by climate change**?** (a. Strongly agree/ b. Agree /c. Neutral /d. Disagree /e. Strongly disagree)

11. What aspects of weather pattern has changed in your community? (a. Increased heat/ b. Changing Rainfall Onset /c. Changing rainfall duration /d. Early rainfall departure)
12. What has been the impacts of perceived climate change in your household? (a. Increased incidence of airbone diseases /b. Low crop yield /c. Increased flooding and Erosion /d. Extreme temperature increase)

Section C: Willingness to Pay for Waste Recycling and Reuse

13. Would you be willing to pay for a sustainable waste management training? (a) Yes, definitely/ b. Maybe,/ c. depending on the cost / d. No, I would not pay

14. If yes, how much would you be willing to pay per month for this service? (Less than 500 Naira /500 - 1000 Naira /More than 1000 Naira)

Market Waste Data

Dear Respondent,

We are a team of researchers from the Centre for Earth Works Development (CFEW), Sustainable Environment Development Initiative (SEDI) and Green Knowledge Foundation and Community Development Advocacy Foundation (CODAF). We are conducting a study on **MULTI-SOLVING ACTION FOR METHANE REDUCTION IN NIGERIA (Lagos, Abuja, Jos and Benin).** We assure you that your participation and the answers you provide in this questionnaire will be kept confidential. We therefore urge you to answer the questions below as honestly as possible.

Thanks in advance for your cooperation.

Sincerely,

Instruction: kindly tick the boxes that best expresses your responses or fill out the blank spaces as the case may be.

S/N	A: Background Characteristics	Responses	Code
01	What is your age?	Actual	.....
02	What is your gender?	Male Female	☐ 1 ☐ 2
03	What is your marital status?	Married Never married Divorced Others	☐ 1 ☐ 2 ☐ 3 ☐ 4
04	What is your highest educational qualification?	School Certificate and below B.Sc./HND Masters Ph.D	☐ 1 ☐ 2 ☐ 3 ☐ 4
05	What is your ethnic group?	Actual	
06	What is monthly income level	Less than N100,000 N100,001 – N200,000 N200,001 – N300,000 Above N3000,000	☐ 1 ☐ 2 ☐ 3 ☐ 4
07	How long have you been in business?	Less than 3years 4- 6years 7-9 years 9 years and above	☐ 1 ☐ 2 ☐ 3 ☐ 4
08	For how long (in years) have you selling here	Less than 3years 4- 6years	☐ 1 ☐ 2

		7-9 years 9 years and above	☐ 3 ☐ 4

Section B: Market Waste Data (Thick where appropriate) (General)

1. How is waste disposed of in your local market? (Waste is separated and collected regularly/ Waste is mixed and collected irregularly / Waste is dumped in open spaces Other (please specify_____)
2. What types of waste are commonly found in markets? (Food and organic waste, /Plastic waste, / Paper and cardboard/ Mixed waste)
3. What are the main challenges in your market waste management? (Lack of waste bins / Irregular waste collection / No awareness about waste separation /No penalties for improper waste disposal)
4. How do people in your area handle household waste? /Separate waste for recycling/ Dispose of all waste together/ Compost organic waste/ Burn waste
5. Do you reuse waste rather than discarding it or recycling it? Yes [ ]/ No [ ]
6. What are the biggest barriers to waste separation, reusing waste and composting in your community? Lack of awareness [ ]/ No access to composting facilities [ ] / No government support [ ]/Cultural habits [ ]
7. Are you award of policies in place to encourage reusing of waste? Clear government policies exist [ ]/ Some policies exist but are not enforced [ ]/ No policies exist [ ]/Don't know [ ]
8. What role should the government play in promoting reusing of waste for waste minimization, or resource recovery such as composting? Provide financial incentives [ ] Conduct awareness campaigns [ ]/ Enforce composting laws [ ]/ No role [ ]
9. Do you think waste sorting will succeed in market place? Strongly agree [ ]/ Agree [ ]/ Neutral [ ]/Disagree [ ]/ Strongly disagree [ ]
10. How does waste management work in market areas? Market vendors separate waste [ ] Waste is collected regularly by authorities [ ] Waste is not separated or collected regularly [ ] Don't know
11. What challenges do market vendors face in managing market waste? Lack of waste bins [ ] Irregular waste collection [ ] No awareness about waste separation [ ] No penalties for improper waste disposal [ ]
12. What factors in your opinion will affect your participation sustainable waste management including sorting and composing? a. Income level [ ]/ b. Educational level [ ]/c Age [ ]/ d. Sex [ ]/ d. Government support/training [ ]
13. How much waste in your area is being reused or recycled instead of being thrown into landfills? High – A significant amount of waste is diverted weekly [ ] Moderate – Some waste is diverted, but most still goes to landfills [ ] Low – Very little waste is diverted [ ] No diversion – All waste ends up in landfills [ ]

Waste Pickers Needs Assessment

Dear Respondent,

We are a team of researchers from the Centre for Earth Works Development (CFEW), Sustainable Environment Development Initiative (SEDI) and Green Knowledge Foundation and Community Development Advocacy Foundation (CODAF). We are conducting a study on **MULTI-SOLVING ACTION FOR METHANE REDUCTION IN NIGERIA (Lagos, Abuja, Jos and Benin).** We assure you that your participation and the answers you provide in this questionnaire will be kept confidential. We therefore urge you to answer the questions below as honestly as possible.

Thanks in advance for your cooperation.

Sincerely,

Instruction: kindly tick the boxes that best expresses your responses or fill out the blank spaces as the case may be.

S/N	A: Background Characteristics	Responses	Code
01	What is your age?	Actual	.....
02	What is your gender?	Male Female	☐ 1 ☐ 2
03	What is your marital status?	Married Never married Divorced Others	☐ 1 ☐ 2 ☐ 3 ☐ 4
04	What is your highest educational qualification?	School Certificate and below B.Sc./HND Masters No education	☐ 1 ☐ 2 ☐ 3 ☐ 4
05	What is your ethnic group?	Actual	
06	What is monthly income level	Less than N100,000 N100,001 – N200,000 N200,001 – N300,000 Above N3000,000	☐ 1 ☐ 2 ☐ 3 ☐ 4
07	How long have you been in working as waste picker	Less than 3years 4- 6years 7-9 years 9 years and above	☐ 1 ☐ 2 ☐ 3 ☐ 4
08	For how long (in years) have you been working n this LGA	Less than 3years 4- 6years 7-9 years 9 years and above	☐ 1 ☐ 2 ☐ 3 ☐ 4

Section B: Market Waste Data (Thick where appropriate) (General)

1. What type of waste do you collect the most?
    a. Plastic [ ]
    b. Paper and cardboard [ ]
    c. Metal and Tin [ ]
    d. Glass/ceramics [ ]
2. What are the biggest challenges you face in waste picking?
    a. Low income [ ]
    b. Poor working conditions. [ ]
    c. Lack of legal recognition [ ]
    d. Harassment by authorities [ ]
    e. Health hazards [ ]
3. Do you have access to protective gear while working?
    a. Yes, always
    b. Sometimes
    c. No, never
4. What support would improve your work conditions?
    a. Better wages [ ]
    b. Legal recognition and protection [ ]
    c. Improved working tools and safety gear [ ]
    d. Access to more waste collection points [ ]
5. Are you part of any waste picker cooperative or association? (Yes/ No)
6. If a formal waste picker registration system existed, would you be willing to register? (Yes/ No/Maybe)
7. What training or skills development would help improve your work?
    a. Safe waste handling and sorting [ ]
    b. Business skills training [ ]
    c. Cooperative management [ ]
    d. Other (please specify) [ ]
8. How do you sell collected waste?
    a. Directly to recyclers [ ]
    b. Through middlemen [ ]
    c. At collection center [ ]
    d. Other (please specify)…….
9. What payment challenges do you face as a waste picker?
    a. Delayed payments [ ]
    b. Unfair pricing [ ]
    c. No fixed buyers [ ]
    d. Other (please specify)……
10. What strategies have been most effective in improving waste sorting efficiency?

- ( ) Training and incentives for waste pickers and managers

- ( ) Better waste collection and sorting infrastructure
- ( ) Stronger policies and enforcement on waste separation
- ( ) Community awareness campaigns and engagement

APPENDIX B:

LOCATION BY LOCATION WASTE COMPOSITION

MSW Characterisation in Benin City, Edo State

Table 1: Composition of waste at Jubilant Citizen dumpsite Benin City, Edo State

Points	Paper		Org.		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	2	8	7	28	5.5	22	2	8	3	12	5.5	22
B	2.5	10	6	24	6	24	3	12	2.5	10	6	24
C	1	4	7.5	30	6	24	2.5	10	3	12	5	20
D	2.5	10	6.5	26	4.5	18	2	8	3	12	6.5	26
E	1.5	6	7	28	5.5	22	1.5	6	2.5	10	7	28
F	1	4	6	24	5	20	2	8	2.5	10	8.5	34
Total	1.8	7.0	6.7	26.7	5.4	21.7	2.2	8.7	2.8	11.0	6.4	25.7

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 2: Composition of waste at Otofure dumpsite Benin City, Edo State

Points	Paper		Org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	3	12	5.5	22	6	24	3	12	2.5	10	5	20
B	2	8	6.5	26	6.5	26	2.5	10	3.5	14	4	16
C	2.5	10	8	32	6	24	2	8	2	8	4.5	18
D	2	8	6.5	26	6	24	3	12	2	8	5.5	22
E	3	12	6.5	26	6	24	2	8	2	8	5	20
F	2.5	10	6	24	6	24	4	16	2	8	4.5	18
Total	2.5	10	6.5	26	6.08	24.3	2.75	11	2.3	9.3	4.75	19

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

MSW Characterisation in Epe, Lagos State

Table 3: Composition of waste at Odo-Mola Iyare Rd, Epe Town, Lagos State (Black spot)

Points	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	1.5	6	13	52	3	12	1	4	1	4	5.5	22
B	1	4	12.5	50	5	20	1.5	6	1	4	4	8
C	1.5	6	12	48	5.5	22	1	4	1.5	6	3.5	14
D	1	4	13	52	5	20	0.5	2	1	4	4.5	18
E	2	8	11	44	4	16	1.5	6	1.5	6	5	20
F	1	4	13	52	3.5	14	1.5	6	1	4	5	20
Mean	1.33	5.33	12.4	49.7	4.33	17.3	1.2	4.7	1.17	4.667	4.58	17

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 4: Composition of waste at Oriyomi Aiyeola St, Epe Town, Lagos State (Black spot)

Points	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	1.5	6	8	32	7	28	2	8	2	8	4.5	18
B	1.5	6	10	40	7	28	1.5	6	1	4	4	16
C	1.5	6	10	40	7	28	1.5	6	1	4	4	16
D	1	4	9	36	6.5	26	1	4	2	8	5.5	22
E	1	4	11	44	6	24	1	4	1.5	6	4.5	18
F	1.5	6	10.5	42	5.5	22	1.5	6	1	4	5	20
Mean	1.3	5.3	9.8	39.0	6.5	26.0	1.4	5.7	1.4	5.7	4.6	18.3

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 5: Composition of waste at Kalejaiye Crescent, Noforija, Epe Town, Lagos State (Black spot)

Points	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	2.5	10	9	36	6	24	1	4	0	0	6.5	26
B	1.5	6	9.5	38	4.5	18	1.5	6	2	8	6	24
C	2	8	10	40	6	24	1.5	6	1	4	4.5	18
D	1.5	6	9	36	5	20	2.5	10	1.5	6	5.5	22
E	2	8	8.5	34	5	20	1.5	6	2	8	6	24
F	1	4	9	36	5.5	22	1	4	1.5	6	7	28
Mean	1.8	7.0	9.2	36.7	5.3	21.3	1.5	6.0	1.3	5.3	5.9	23.7

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 6: Composition of waste at designated public Bin, 11th street, Federal Low Cost Area Jos North

Points	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	3	12	6.5	26	5.5	22	2.5	10	3	12	4.5	18
B	2.5	10	8	32	5.5	22	3.5	14	2	8	4.5	18
C	2	8	7	28	6	24	3	12	3.5	14	3.5	14
D	1.5	6	8	32	6	24	2.5	10	3	12	4	16
E	2.5	10	6.5	26	6.5	26	2.5	10	2.5	10	5.5	22
F	1.5	6	8	32	6	24	3	12	2	8	4.5	18
Mean	2.2	8.7	7.3	29.3	5.9	23.7	2.8	11.3	2.7	10.7	4.4	17.7

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 7: Composition of waste at designated public Bin, Miango Road, Jos North

Points	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	3.5	14	6	24	4	16	3	12	2.5	10	6	24
B	3	12	7	28	5	20	2.5	6	1	4	6.5	26
C	3	12	5.5	22	5	20	2.5	6	2	8	7	28
D	2.5	10	7.5	30	5	20	3	8	1	4	6	24
E	3	12	7	28	6	24	2	4	1.5	6	5.5	22
F	2	8	7	28	5.5	22	3	12	2.5	10	5	20
Mean	2.833	11.33	6.67	26.67	5.08	20.3	2.67	8	1.75	7	6	24

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 8: Composition of waste at designated public Bin, Dadin Kowa Loop, Jos south

	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	1	4	12	48	6	24	1	4	0.5	2	4.5	18
B	1	4	12	52	5.5	22	1.5	6	2	8	2	8
C	1.5	6	10	40	7	28	1.5	6	1.5	6	3.5	14
D	1.5	6	12	48	6	24	1	4	1	4	3.5	14
E	2.5	10	8	32	6.5	26	1	4	1	12	4	16
F	2	8	13	52	4.5	18	1.5	6	1.5	6	3	12
Mean	1.58	6.3	11.2	45.3	5.9	23.7	1.3	5.0	1.3	6.3	3.4	13.7

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 9: Composition of waste at designated public Bin, Zamangada-Rayfield, Jos south

	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	2.5	10	14	56	4	16	1	4	1.5	6	2	8
B	2	8	12	48	4.5	18	1	4	2	8	3.5	14
C	1.5	6	13	52	5	20	1.5	6	1	4	3	12
D	2	8	12	48	6	24	1.5	6	1	4	2.5	10
E	2.5	10	10.5	42	4	16	2	8	2	8	4	16
F	2.5	10	11.5	46	5.5	22	1	4	1.5	6	3	12
Mean	2.17	8.7	12.2	48.7	4.8	19.3	1.3	5.3	1.5	6.0	3.0	12.0

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

MSW Characterisation in FCT Abuja

Table 10: Composition of waste at Mabushi Open dumpsite, FCT , Abuja

Points	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	2	8	9.5	38	9	36	1	4	1.5	10	1	4
B	1.5	6	9	36	8.5	34	2	8	1	4	3	12
C	1.5	6	10	40	9.5	38	1	4	2	8	1	4
D	2.5	10	9	36	8	32	1	4	3	12	1.5	6
E	2	8	9	36	7.5	30	2.5	10	2	2	2	8
F	2	8	10	40	9	36	1.5	6	1	1.5	1.5	6
Mean	1.917	7.7	9.4	37.7	8.6	34.3	1.5	6.0	1.8	6.3	1.7	6.7

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 11: Composition of waste at Rock of Ages Mall, Obafemi Awolowo Way, Utako, FCT, Abuja (illegal dumpsite)

	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	2	8	9	36	9	36	1	4	1	4	3	12
B	1.5	6	10	40	8.5	34	1.5	6	1.5	6	2	8
C	1.5	6	9	36	9	36	1.5	6	2	8	2	8
D	2.5	10	9.5	38	8	32	2	8	1.5	6	6	6
Mean	1.875	7.5	9.375	37.5	8.625	34.5	1.5	6	1.5	6	3.25	8.5

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 12: Composition of waste at designated waste bin, Mike Akhigbe Way, Jabi FCT, Abuja

	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	2	8	11.5	46	3.5	14	1	4	5	20	2	8
B	2	8	11.5	46	5	20	0.5	2	4	16	2	8
C	2	8	9.5	38	5.5	22	1	4	4	16	3	12
D	2	8	10.5	42	5	20	0.5	2	20	20	2	8
Mean	2	8	10.8	43	4.75	19	0.8	3	8.25	18	2.25	9

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

Table 13: Composition of waste at Gosa dumpsite, FCT, Abuja

	Paper		org		Plastics		Wood		Garden		Others	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
A	0.5	2	11	44	6.5	26	2	8	1	4	4	16
B	0.5	2	12.5	50	7	28	2.5	10	1	4	1.5	6
C	1	4	10	40	7	28	1.5	6	1.5	6	4	16
D	1	4	11.5	46	6.5	26	2	8	1	4	3	12
E	2	8	10.5	42	7	28	1.5	6	2	8	2	8
F	1.5	6	9.5	38	7.5	30	2	8	1.5	6	3	12
Mean	1.08	4.3	10.8	43.3	6.9	27.7	1.9	7.7	1.3	5.3	2.9	11.7

Org: organics (Food, fruit waste). Others (textile, glass/ceramics/metals/aluminium)
Source: Field study (2025)

APPENDIX C:

LOCATION BY LOCATION METHANE VALUES FROM DUMPSITES

Methane Values from Dumpsites in Benin City, Edo State

Table 1: Methane values from Jubilant Citizen operated dumpsite in Benin City, Edo State

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	$Q_{CH4/Yr}$
A	135,896	0.74	0.6	0.1184	0.77	0.5	1.333	1	**3666.34**
B	135,896	0.74	0.6	0.129	0.77	0.5	1.333	1	**3994.57**
C	135,896	0.74	0.6	0.1114	0.77	0.5	1.333	1	**3449.58**
D	135,896	0.74	0.6	0.1234	0.77	0.5	1.333	1	**3821.16**
E	135,896	0.74	0.6	0.101	0.77	0.5	1.333	1	**3127.53**
F	135,896	0.74	0.6	0.093	0.77	0.5	1.333	1	**2879.81**

Table 2: Methane values from government operated Otofure dumpsite in Benin City, Edo State

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	$Q_{CH4/yr}$
A	54,673	0.74	0.6	**0.134**	0.77	0.5	1.333	1	**1669.37**
B	54,673	0.74	0.6	**0.125**	0.77	0.5	1.333	1	**1554.75**
C	54,673	0.74	0.6	**0.126**	0.77	0.5	1.333	1	**1564.72**
D	54,673	0.74	0.6	**0.121**	0.77	0.5	1.333	1	**1502.43**
E	54,673	0.74	0.6	**0.125**	0.77	0.5	1.333	1	**1552.26**
F	54,673	0.74	0.6	**0.138**	0.77	0.5	1.333	1	**1714.21**

Methane Values from Dumpsites in Epe Town, Lagos State

Table 3: Methane values from Odo-Mola Iyare Rd, dumpsite Epe Town, Lagos State (Black spot)

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	155,485	0.74	0.6	0.1208	0.77	0.5	1.333	1	**4279.86**
B	155,485	0.74	0.6	0.1158	0.77	0.5	1.333	1	**4102.71**
C	155,485	0.74	0.6	0.1182	0.77	0.5	1.333	1	**4187.74**
D	155,485	0.74	0.6	0.1068	0.77	0.5	1.333	1	**3783.85**
E	155,485	0.74	0.6	0.1262	0.77	0.5	1.333	1	**4471.18**
F	155,485	0.74	0.6	0.1188	0.77	0.5	1.333	1	**4209.00**

Table 4: Methane values from Oriyomi Aiyeola St, dumpsite, Epe Town, Lagos State (Black spot)

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	155,485	0.74	0.6	0.1096	0.77	0.5	1.333	1	**3883.05**
B	155,485	0.74	0.6	0.1088	0.77	0.5	1.333	1	**3854.71**
C	155,485	0.74	0.6	0.0956	0.77	0.5	1.333	1	**3387.04**
D	155,485	0.74	0.6	0.1042	0.77	0.5	1.333	1	**3691.73**
E	155,485	0.74	0.6	0.1118	0.77	0.5	1.333	1	**3960.99**

Table 5: Methane values from Kalejaiye Crescent, Noforija dumpsite, Epe Town, Lagos State (Black spot)

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	155,485	0.74	0.6	0.106	0.77	0.5	1.333	1	**3755.50**
B	155,485	0.74	0.6	0.1126	0.77	0.5	1.333	1	**3989.34**
C	155,485	0.74	0.6	0.1168	0.77	0.5	1.333	1	**4138.14**
D	155,485	0.74	0.6	0.1182	0.77	0.5	1.333	1	**4187.74**
E	155,485	0.74	0.6	0.1146	0.77	0.5	1.333	1	**4060.20**
F	155,485	0.74	0.6	0.0922	0.77	0.5	1.333	1	**3266.58**

Methane Values from Dumpsites in Jos, Plateau State

Table 6: Methane values from designated public Bin, 11th street, Federal Low Cost Area Jos North

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	$Q_{CH4/yr}$
A	174,706	0.74	0.6	0.137	0.77	0.5	1.333	1	**5453.84**
B	174,706	0.74	0.6	0.144	0.77	0.5	1.333	1	**5732.50**
C	174,706	0.74	0.6	0.134	0.77	0.5	1.333	1	**5334.41**
D	174,706	0.74	0.6	0.122	0.77	0.5	1.333	1	**4856.70**
E	174,706	0.74	0.6	0.126	0.77	0.5	1.333	1	**5015.94**
F	174,706	0.74	0.6	0.122	0.77	0.5	1.333	1	**4856.70**

Table 7: Methane values from designated public Bin, Miango Road, Jos North

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	174,706	0.74	0.6	0.145	0.77	0.5	1.333	1	**5772.31**
B	174,706	0.74	0.6	0.115	0.77	0.5	1.333	1	**4578.04**
C	174,706	0.74	0.6	0.113	0.77	0.5	1.333	1	**4498.42**

D	174,706	0.74	0.6	0.116	0.77	0.5	1.333	1	**4617.85**
E	174,706	0.74	0.6	0.112	0.77	0.5	1.333	1	**4458.61**
F	174,706	0.74	0.6	0.127	0.77	0.5	1.333	1	**5055.75**

Table 8: Methane values from designated public Bin, Dadin Kowa Loop, Jos south

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	120,137	0.74	0.6	0.103	0.77	0.5	1.333	1	**2819.60**
B	120,137	0.74	0.6	0.126	0.77	0.5	1.333	1	**3449.22**
C	120,137	0.74	0.6	0.112	0.77	0.5	1.333	1	**3065.98**
D	120,137	0.74	0.6	0.115	0.77	0.5	1.333	1	**3148.10**
E	120,137	0.74	0.6	0.12	0.77	0.5	1.333	1	**3284.97**
F	120,137	0.74	0.6	0.138	0.77	0.5	1.333	1	**3777.72**

Table 9: Methane values from designated public Bin, Zamangada-Rayfield, Jos south

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	120,137	0.74	0.6	0.146	0.77	0.5	1.333	1	**3996.72**
B	120,137	0.74	0.6	0.13	0.77	0.5	1.333	1	**3558.72**
C	120,137	0.74	0.6	0.127	0.77	0.5	1.333	1	**3476.60**
D	120,137	0.74	0.6	0.129	0.77	0.5	1.333	1	**3531.35**
E	120,137	0.74	0.6	0.14	0.77	0.5	1.333	1	**3832.47**
F	120,137	0.74	0.6	0.131	0.77	0.5	1.333	1	**3586.10**

Methane values from dumpsites in the FCT, Abuja

Table 10: Methane values from government operated Mabushi Dumpsite, FCT, Abuja

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}

A	465,086	0.74	0.6	0.118	0.77	0.5	1.333	1	**12505.16**
B	465,086	0.74	0.6	0.109	0.77	0.5	1.333	1	**11551.37**
C	465,086	0.74	0.6	0.11	0.77	0.5	1.333	1	**11657.35**
D	465,086	0.74	0.6	0.126	0.77	0.5	1.333	1	**13352.96**
E	465,086	0.74	0.6	0.13	0.77	0.5	1.333	1	**13776.87**
F	465,086	0.74	0.6	0.117	0.77	0.5	1.333	1	**12399.18**

Table 11: Methane values from illegal dumpsite at Rock of Ages Mall, Obafemi Awolowo Way, Utako, FCT , Abuja

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	465,086	0.74	0.6	0.105	0.77	0.5	1.333	1	**11127.47**
B	465,086	0.74	0.6	0.112	0.77	0.5	1.333	1	**11869.30**
C	465,086	0.74	0.6	0.11	0.77	0.5	1.333	1	**11657.35**
D	465,086	0.74	0.6	0.131	0.77	0.5	1.333	1	**13882.84**

Table 12: Methane values from designated public Bin, Mike Akhigbe Way, Jabi FCT, Abuja

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	465,086	0.74	0.6	0.147	0.77	0.5	1.333	1	**15578.46**
B	465,086	0.74	0.6	0.134	0.77	0.5	1.333	1	**14200.77**
C	465,086	0.74	0.6	0.128	0.77	0.5	1.333	1	**13564.92**
D	465,086	0.74	0.6	0.135	0.77	0.5	1.333	1	**14306.75**

Table 13: Methane values from Gosa dumpsite, FCT, Abuja

POINT	MSW_T	MSW_F	MCF	DOC	DOC_F	F	(16/12) -R	1 - OX	Q_{CH4}
A	465,086	0.74	0.6	0.105	0.77	0.5	1.333	1	**11127.47**
B	465,086	0.74	0.6	0.12	0.77	0.5	1.333	1	**12717.11**

C	465,086	0.74	0.6	0.104	0.77	0.5	1.333	1	**11021.49**
D	465,086	0.74	0.6	0.116	0.77	0.5	1.333	1	**12293.20**
E	465,086	0.74	0.6	0.127	0.77	0.5	1.333	1	**13458.94**
F	465,086	0.74	0.6	0.115	0.77	0.5	1.333	1	**12187.23**