

**SOLID WASTE MANAGEMENT IN BENIN CITY: THE
POTENTIAL OF MAIZE (*Zea mays*) HUSKS WASTES AS ANIMAL
FEED**

BY

Sylvanus Ayes AIHEBHO

UNIVERSITY OF BENIN

BENIN CITY

January, 2026.

**SOLID WASTE MANAGEMENT IN BENIN CITY: THE
POTENTIAL OF MAIZE (*Zea mays*) HUSKS WASTES AS ANIMAL
FEED**

BY

Sylvanus Ayes AIHEBHO

PG/LSC1119779

B.Sc, PGD, M.Sc (Benin)

**A Thesis Written in the Department of Animal and Environmental Biology and
Submitted to the College of Postgraduate Studies in Partial Fulfillment of the
Requirements for the Degree of Master of Philosophy M.Phil. of the University of
Benin, Benin City.**

CERTIFICATION

We certify that this work was carried out by Mr. **Sylvanus Ayes AIHEBHO** in the Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Benin City, Edo State, Nigeria.

Signature & Date.....

Professor Tunde O.T. Imoobe
Supervisor

Signature & Date.....

Professor Isioma Tongo
Head of Department

CERTIFICATION OF THESIS

We the under listed attest and declare that the thesis of Mr. Sylvanus Ayes AIHEBHO

Titled: Solid Waste Management In Benin City: The Potential of Maize (*Zea mays*) Husks Wastes as Animal Feed has successfully passed the anti-plagiarism test and does not violate any copyright regulations.

Sign & Date.....

Professor Tunde O.T. Imoobe

Supervisor

Sign & Date.....

Professor Isioma Tongo

Head of Department

DEDICATION

I dedicate this research project to God Almighty who by his infinite grace and mercies gave me the strength, understanding and wisdom to achieve my dream.

ACKNOWLEDGEMENTS

With gratitude in my heart, I am most grateful to God who has been my source of strength. I am grateful to my supervisor Professor T. O. T. Imoobe for his patience, guidance, immeasurable assistance and encouragement without him this research work would not have been a success.

The entire staff of the Department of Animal and Environmental Biology including Professor T. O. T. Imoobe, Professor I. Tongo, Dr. N. Erhunmuse and lecturers, also to the, University of Benin for given me the opportunity to study.

Special thanks to my Mother Mrs. J. Aihebho, my brother Osaze Aihebho, and the entire family for their love, prayers and encouragement.

TABLE OF CONTENTS

Title Page	i
Cover Page	ii
Certification	iii
Certification of Thesis	iv
Dedication	v
Acknowledgement	vi
Table of Contents	vii
List of Figures	viii
List of Plates	ix
List of Tables	x
Abstract	xi
CHAPTER ONE: INTRODUCTION	1
1.1 Justification for the Study	16
1.2 1.2 Aim and Objectives of the Study	17
CHAPTER TWO: LITERATURE REVIEW	18
2.2 Functional Elements of Waste Management	20
2.3 Overview of Management of Solid Waste	29
CHAPTER THREE: MATERIALS AND METHODS	32
3.1 Study Area	32

3.2 Site Description	35
3.3: Materials and Methods	43
3.4: Data Collection and Methods	42
3.5: Moisture Content Determination	45
3.6: Lipid Content Determination	45
3.7: Ash Content Determination	46
3.8: Protein of Non Fat Extract (NFE)	46
3.9: Determination of None Fat Extract (NFE)	47
3.10: Statistical Data Analysis	47
CHAPTER FOUR: RESULTS	48
4.1: Demographic Characteristics of Respondents	48
4.2: Waste Generation and Disposal Mechanisms	50
4.3: Waste Recycling Practices	53
4.4: Environmental Challenges	54
4.5: Relationship between Educational Level and Awareness of Recycling	56
4.6 Test for nutritional value of freshly unboiled and boiled maize husks	60
CHAPTER FIVE: DISCUSSION	63
5.1: Demographic Characteristics/Distinguished Features of the Respondents	63
5.2 Maize Husk Waste as Animal Feed	68

5.3: Conclusion	68
5.4: Recommendation	69
REFERENCES	71
APPENDICES	83

LIST OF FIGURES

Figure	Title	Page
2.1:	Relationship of functional element of Waste Management	19
2.2:	The Waste Hierarchy	26
3.1:	Map of Oredo LGA, Edo State and Nigeria	34
4.1:	Types of Waste	50
4.2:	Disposal Method	52
4.3:	Recycling Awareness	54
4.4:	Environmental Challenges	56
4.5:	Cross - Tabulation of Educational Level and Awareness of Recycling	58

LIST OF PLATES

Plate	Title	Page
3.1:	Illegal Dumpsite Around Sec Jun by New Lagos Rd, Victory Str	36
3.2:	Illegal Dumpsite at Ikpoba Slope, Victory Street Area	36
3.3:	Illegal Dumps Along Oba Market Rd	37
3.4:	Illegal Dumps Along Oba Market Opp Bob Izua Motor Park	37
3.5:	Solid Wastes Removed from Gutter and abandoned at Oba Market	38
3.6:	Illegal Dumpsite at Victory Street, New Benin	38
3.7:	Illegal Dumps Benin Victory Street	39
3.8:	Illegal Dumpsite Located at Ikpoba Slop	39
3.9:	Illegal Dumpsite Around Slop and Victory Street	40
3.10:	An Illegal Dumps Behind Victory Street, New Benin Market	40
3.11:	Illegal Dumpsite at New Benin Market by Victory	41
3.12:	Illegal Dumpsite at Victory Street, New Benin	41
3.13:	Illegal Dumps Behind Ikpoba Slop and Victory Rd	42
3.14:	Illegal Dumpsite at Ikpoba Slop and Victory Str Axis	42

LIST OF TABLES

Table	Title	Page
4.1:	Demographic Characteristics	48
4.2:	Types of Waste Generated	49
4.3:	Waste Disposal Methods	51
4.4:	Recycling Awareness and Practices	53
4.5:	Environmental Challenges	55
4.6:	Cross-tabulation of Educational Level and Awareness of Recycling	57
4.7:	Chi-Square Test Results for Educational Level and Awareness of Recycling	59
4.8:	Analytes of interest: Proximate Analysis	60

ABSTRACT

Solid waste generation and management is a major concern for both developed and developing countries. Because of population density, consumption pattern, production activities and rural-urban migration, solid waste management has become a major environmental issue and problem in major cities. The purpose of the study was to view, analyze and interpret waste generation, disposal methods mechanism, environmental impacts associated with waste management; nutritional value of maize (*Zea mays*) husks as animal feed.

The primary data were obtained via questionnaires administered to a randomly selected population in the study area. Oral interviews and field observation were also carried out for holistic assessment. The questionnaires had questions on demographic characteristics, waste management matters, and collection of maize (*Zea mays*) husks waste. Proximate analysis and test for nutritional value of freshly unboiled and boiled maize (*Zea mays*) husks were carried out in the Benin Owena laboratory. The secondary data were obtained from relevant literatures.

Results indicated that streets, roads and open spaces were used as waste dumps; ineffectiveness of waste managers contributed to the problem of waste management. Data revealed that almost equal gender respondents, with (49.5%) males and (50.5%) females. The highest respondents were 50-59years. Educational status recorded highest (29.5%), followed by middle school (20.5%). Food waste accounted for the largest proportion of waste generated (40%), followed by plastics (30%). Public bins (28.75%) and roadside disposal (25.5%) were the most common waste disposal methods. However, environmentally unfriendly practices like open space disposal (15.5%) and roadside

dumping highlighted the need for improved waste management infrastructure. While majority (68%) was aware of recycling, only a minority (32%) actively engaged in the practice. This gap underscores the challenges posed by inadequate facilities and limited information, suggesting areas for intervention to promote recycling culture. Waste pollution emerged as the most significant environmental challenge (62%), followed by health hazards (48%). The presence of rodents at disposal sites (38%) further highlighted the public health implications of poor waste management practices. The chi-square test showed a significant relationship between educational level and awareness of recycling ($\chi^2 = 16.27$, $p < 0.012$). Freshly unboiled maize (*Zea mays*) husks had higher carbohydrate content (79.89%), which was a key energy source for animals, particularly in livestock and poultry feed than the boiled corncobs (76.51%). On the other hand, the boiled maize (*Zea mays*) husks had slightly higher crude protein content (4.62% vs. 3.13%) and more fiber (14.65% vs. 13.87%) than the unboiled, which could be beneficial for animals requiring a higher protein or fiber intake. Thus, it is recommended that these findings highlighted the importance of educational campaigns to increase recycling awareness across all sectors, and that freshly unboiled maize (*Zea mays*) husk are better for energy-rich feed, while boiled corncobs might be more suited for a more balanced diet requiring higher fiber and protein content for livestock and poultry.

CHAPTER ONE

INTRODUCTION

Solid waste management is the complete process of collection, treatment and disposal of solid wastes. Because of population density, consumption pattern, production activities and rural-urban migration, solid waste management is a major environmental matter/problem in most cities across the globe, particularly in Benin City and Nigeria. In Nigerian urban cities like Benin, Aba, Onitsha, Owerri, Lagos, Port Harcourt, Kaduna, Calabar among others, billions tons of waste are generated year in, year out (Ogboi and Okosun (2003). The main sources of waste generation in Nigeria are agricultural waste, industrial waste, and municipal waste.

Human's unregulated activities in terms of development and ineffective solid waste management, exponential increase in urban population and increase in industrial activities are serious threats to solid waste management in cities across Nigeria. This ugly situation has resulted in the degradation of the environment and outbreak of diseases like cholera and diarrhea as reported by Uchegbu (1998). Wastes are produced in almost all human activities therefore, waste generation and management is everyone's business. Both the government and non-governmental bodies have made frantic effort recently to manage waste in most cities in Nigeria. Such attempt does not seem to have yielded positive impact as most major cities are littered with solid waste in strategic locations like markets and streets. Most residents in urban cities are not conscious of the consequences of improper waste disposal to mankind and the environment. Thus, it has become

imperative to properly educate all the urban dwellers on the consequences of improper waste disposal to the environment and man.

Waste as equally defined as any kind of material that is not avoidable arising from household or industrial operation with no economic demand which must be disposed Odocha (1994). Wastes are materials that may no longer be needed for, but may become a feed stock or raw material elsewhere. Odocha (1994) said that wastes are those materials which are generated as a result of normal operational activities which we have control over in terms of their production and disposal/discharged. That wastes are substances in form of solid, liquid or gaseous that remains as residue or by-product of the processing of a substance and for which no use can be found by the system that produces it.

Solid waste is left-over arising from humans, animals or plants activities that are normally discarded as no longer useful or useless. Solid waste is any useless, unwanted or discarded material that is not liquid or gaseous. Solid waste includes household garbage or rubbish, commercial refuse, industrial waste, street sweeping, construction and demolition debris, sanitation residue, abandoned automobile and dead bodies, as reported by Anijah-Obi. (2001).

Lawal *et al*, (2010) described solid wastes as materials not needed from houses, street, commercial, industrial and agricultural activities/operations. These wastes are made up of countless and plenty different materials like dust, food wastes, papers, leaves, metals among others.

He categorized solid waste into residential, industrial, commercial, municipal and transportation. Residential and commercial solid waste include: Garbage, rubbish which include papers, cardboard wood, bones, plastics, clothes, rubbers, leaves leather which are purely combustible and noncombustible solid waste which include, metals, tins, cans, bricks, ceramics glass, bottles and residues from cooking. Municipal and transportation wastes are bulk waste found in the streets. They include discarded large motor parts, tires, refrigerators, furniture and so on. Industrial solid waste are industrial refuse, construction and demolition wastes, sewage treatment residues, animal and agricultural waste and special waste – hazardous waste, pathological waste, explosives, radioactive materials, security wastes, etc.

Anijah (2001) identified two types of solid waste (a) industrials solid waste and (b) commercial and domestic solid wastes. Industrial solid waste materials are generated in the course of manufacturing process, while domestic solid wastes are the by-products of house activities and consumption such as wrapping papers, vegetable, empty cans, bottles or containers. Industrial and domestic wastes were further categorized into those that can be rapidly decomposed by natural processes or engineering systems such as leaves bones, cotton rags. These are otherwise known as biodegradable wastes. On the contrary, non-biodegradable waste are not broken down or decomposed by natural means/process but they can be recycled. Cunningham *et al*, (2005) also categorized solid waste into industrial waste and municipal waste. According to them industrial solid waste include waste from mining and mineral production, while municipal solid waste is a combination of household and commercial refuse.

The concept of solid waste management is described as the appropriate methodology of disposing wastes safely in such a way that makes it less harmful. It could come in form of treatment and energy conservation. It refers to the process of collecting and treating solid waste. It also offers solutions for the recycling items that do not belong to garbage or trash. Solid waste management consists of all the activities required to manage waste from its inception to its final disposal Cunningham *et al*, (2005).

Poor management of solid waste has resulted in serious environmental problems presently being seen in various cities and towns in Nigeria. A major reason liable for rise in waste generation in country Nigeria as attributed to the rapid growth in urban settlement which has resulted in a value beyond the level that the city authorities can care for. This of course has caused a poor system of solid waste management and this may ensue in unbearable environmental problems and crisis in most towns in Nigeria (Umunna, 2009).

Quite a number of laws and regulations have been enacted by the federal, state and local governments of Nigeria, in response to the problem of solid waste management and with a view to safeguarding the environment. One of such laws and regulations is the Federal Environmental agency act of 1988. The act of managing and enforcing these environmental laws is that of the Federal Ministry of Environment which took over the constitution in 1999 from the Federal Environmental Protection Agency (FEPA), created under FEPA Act". State and local governments in the country before the FEPA Act, were to set up their own environment within its jurisdiction. It is pertinent to note that the issue of managing solid waste is one main responsibility of both the state and local government agencies.

These agencies control the handling and disposal of solid waste generated. These state agencies also generate funds via revenue generated from sanitary levy and strict regulations with heavy penalties for offenders for illegal dumping or littering of refuse along the street as well as from subvention obtained from the state government as reported by (Ogwueleka, 2003). In spite of the efforts of the agencies of the state and local governments, and the laws and regulations put in place by the federal government agencies, most towns and cities in Nigeria are still faced with the problem of non-evacuation of huge pileups of waste daily from their streets and markets. The reason is not far-fetched as residents of these cities dump waste indiscriminately. A study done by Ogboi and Okosun (2003) reported that residents of Onitsha, Benin city, Lagos, Ibadan, Kano, Enugu among others states in Nigeria dump waste indiscriminately along the streets, roads, open spaces, market place, frontages of residential buildings and drainage systems. An ugly attitude that has resulted in a buildup of refuse, a common sight of Nigeria's urban landscape.

This research was focused at Oredo LGA, in Benin City where the state government has established policies to improve the sanitary conditions of the environment. Such policy is termed the Edo State waste management policy to support the guidelines of national environmental policy. Nwaka (2005) reported that the hindrance to such policy is lack of proper implementation that could curtail the adverse impacts of wastes on the environment. The Edo State solid waste management policy is aimed at handling sanitation issues in Benin City particularly. Beautification plans was organized by the government to developed "solid waste management" by employing active waste managers in the metropolis with creation of zones to improve such plans. Even with the

policies, machinery and equipment of waste management, market places, streets, road sides, and open spaces are still littered with mountain of solid waste, which implies that the policies for waste management in the city may have failed its task to improve the cleaning conditions of the environment by (Agba, 2010). Wastes are unavoidable, wherever human's activities are found, waste generation is unavoidable. An important aspect of waste management is the collection, whenever waste is generated. Production of waste is not a problem: the problem arises when the waste is not well managed, thereby causing environmental pollution. Adejobi and Olorunnimbe (2012) noted that the volume of waste generated that constitutes environmental issues, that the inability of agencies, governments and individuals to follow up with proper management that constitutes and make up the burden of wastes in our environment. The commonly used methods of solid waste management such as landfilling, incineration, composting and anaerobic digestion are technologies known to reduce volume of waste (Seo *et al.*, 2004). Solid waste management constitutes most crucial health and environmental problems facing African cities. Poverty, rapid population growth, high urbanization rate, with under-funded government prevents efficient management of wastes. Abdulahi (2009) reported that the rate at which wastes are generated in our communities are very high rate with increase in population, changes in our lifestyle including technological development. In spite of the fact that cities/towns in Africa use 20-50 percent of their financial budget in waste management, just only 20-80 percent of the waste is collected and evacuated properly (Abdulahi 2009). Open dumping, open burning and un-engineered sanitary landfills are common practices all over the country. Because of improper practice of solid waste

collection, transportation and disposal, inhabitants are facing serious negative environmental impacts.

Environmental impacts of solid waste are enormous. “Environment” means: The living and non-living surroundings, natural or man-made, which makes life on earth possible. Long time ago, landfills were used to solve problems of environmental pollution, to safeguard lives and properties, the environment and societal debilitating impacts/effects in view of alternative methodology of waste evacuation like public burning, public-pit dumps, waste dumps on water bodies, therefore landfills helped in removing some old practices of environmental impacts. But newer methods were found due to gas and leachate formation which is another form of environmental impact arising from landfill. Besides, potential health hazard such as fire and explosions, vegetation damage, unpleasant smells, landfills settlement, ground water pollution, air pollution, global warming are included (Abdulahi 2009).

Improper solid waste management is associated with negative environmental impacts like blockage of drains as a result of disposed waste from illegal dumpsites. Flies and other pathogenic insects breeds are so connected with open/public waste, the open/public burning of waste collected and retrieved directly warrant environmental air pollution. Abdulahi (2009), viewed that neglected waste arising in some part of the town are environmentally degrading the urban landscape with negative efforts/attitudes abducted in keeping the environment neatly, due to lack of health and safety facilities to the waste collection crew in the city, they are specifically facing occupational hazards, including strains from lifting, injuries from sharp objects and traffic accidents. Discarded polythene bags in collected solid waste from the city are generating an aesthetic nuisance and they

may also cause the death of grazing animals when eat them. Open dumpsites on the roadside and heavily sized solid waste storage containers are also creating traffic blockage in the study area.

The local government is not providing facilities to separate waste. As a result, a lot of dangerous items such as broken glasses, razor blades, knife, cutlasses, and hypodermic needles and other healthcare wastes, aerosol cans and potentially explosive containers and chemicals from industries may cause risks of injury or poisoning, particularly to scavengers and school going children. During raining seasons, produced leachate from the open dumpsites is causing serious pollution to water bodies in the city, a high percentage of collected solid waste from the city is being treated or disposed of in unsatisfactory ways, causing a severe aesthetic nuisance in terms of smell and manifestation, liquids and fumes, escaping from deposits of chemical wastes are creating fatal or other serious effects to the community. Illegal burning of collected solid waste in the city is creating serious negative impacts on outdoor air quality furthermore, it is also causing illness and reducing visibility (Seo *et al.*, 2004).

The most serious challenges to solid waste management in most cities are collection, disposal, and evacuation (Donevska *et al.*, 2006) report that the uncollected wastes that was illegally dumped in open spaces, water bodies, and water ways, burnt or dropped on the streets are disturbing. Disease condition are prevalence, such as cholera, tetanus, malaria, even diarrhea in many African countries are in connection with unsanitary conditions caused by waste being much scattered in public places (McMichael, 2000). Diseases were also recorded due to contact with smokes from burning of waste in public places (Oyelola *et al.*, 2009).

Increase in flooding was also linked to drainage blockage due to improper disposal of waste. Folorunso and Awosika (2001) equally linked flooding in Lagos State of Nigeria to clogging of drains by solid wastes. In Nigeria, the common method of solid waste disposal is open dumps (Onwughara *et al.*, 2010). Socio-economic and population growth are linked to high increase in solid waste production. Omole and Alakinde (2013) observed that third world countries like Nigeria continuously observing exponential increase in population growth up-to-date in cities. Inhabitants are relocated from their aboriginal villages to cities and township due to quick development, industrialization, civilization in terms of urbanization with much effects on land activities, if not properly managed, it might lead to unapproved structures of houses that is characterized features in most parts of Benin City, especially Oredo LGA. These and much have greatly affected master plans of the city, thereby also affected socio economic activities like solid waste collection due to indiscriminate disposal of waste. Solid waste is a result of discarded materials from operational activities in various land use like residential, commercial, industrial, etc.

Household (residential) solid wastes are those arising from living quarters regularly, like organic matters via making and consumption of foods, papers, nylon and so on, are left over from cooking and other household activities. Commercial waste arises from shops, super markets, and market places, such as nylon, cartons, polythene bags, papers among others. Industrial wastes are also called company wastes, such as solid, liquid; sludge because they can be poisonous, toxic, and hazardous. Company and industrial wastes like metals, glasses, scraps, sawdust, paper pieces etc., by Omole and Alakinde (2013). Abila

and Kantola (2013) viewed it and states that solid waste management problems in Nigeria cut across concern for human health, air, water and land pollution.

The concept of solid waste management for sustainable development describes the basic principles and recent advances for handling solid waste in an environmentally sustainable way. It refers to efficient, safe, treatment and disposal of hazardous and other waste. It is a strategy for achieving environmental quality in both the developing and developed world. Sustainable development means; promoting development at a rate and such a way as to ensure that quality of the environment and the supply of the resources are maintained and whenever practicable, enhance to meet the needs of the present generation without compromising future generation need. Enger and Smith (2000) stress that lack of space for dumping of solid waste has become a major problem for many large metropolitan areas throughout the world. They also added that increase population in urban towns and cities across the globe, lack of suitable land available for landfills as well as increase financial burden on communities are the major factors responsible for unsustainable solid waste management. Uchegbu (1998) identified tremendous urban growth as a result of the rural-urban draft as a major factor responsible for unsustainable solid waste management. According to him the growth in population has given rise to the rising mountains of garbage which now characterize most of our towns and cities. He further stressed that in the case of refusal; its collection and disposal have become the most glaring problem in urban towns and cities, since Nigeria independence that have defied solution. He further maintained that most of the problem of solid waste management in developing countries including Nigeria could be attributed to myriad of factors which include, inadequate funding, inappropriate technology, lack of or

ineffective implementation of government policies, behavioral pattern of the populace and lack of awareness.

Lawal *et al*, (2010) stressed that large population which generate complementary high volumes of wastes that cannot be easily disposed is one of the major factors responsible for unsustainable solid waste disposal. Other factors according to them include; apathy on the side of urban dwellers; bureaucratic bottlenecks that do not give way for easy sourcing of funds, adequate manpower and functional tools required for managing waste; the role of waste management authorities and the huge amount of money involved in waste management. Uchendu, *et al*, (2010) identified factors responsible for unsustainable solid waste management to include. Institutional problems, delay or unwillingness to enact new laws to bring environmental management as closely as possible as it is the practice in developed countries, lack of or inadequate staff training and man power development, poor strategies adopted to manage waste and financial support.

A good solid waste management is an important aspect for the adequate protection to safeguard public health, safety and quality environment according to Breeze (2012). Increase in the amount of consumption globally, waste generation, including high density of very low income living environments with little to no good road access are some problems facing improper planned are as in most cities and town (Breeze, 2012). Privatization of waste collection, waste studied. “He also carried out studies on governance of solid waste management in Africa, particularly taking Dar es Salam as a case study.” He also contributed that solid waste management require to be investigated

periodically because of exponential population growth. That socio economic activity may affect waste management.

It is the part that describes the general focus of the study. Daskalopoulos *et al*, (1999), states that this represents the general focus of the study. In management processes of solid waste, we have a lot of functional elements, if they are implemented/established very well, to enable management of solid waste sustainably possible. The elements are generation, storage, and collection. Wastes that are collected are transferred to collection centers or points of collection, then transported to the municipal or city dumps, treated/processed and recovered, recycled.

Wastes are materials that may no longer be needed but may become food or feed stock or raw material elsewhere. Very huge consumption in the nearest future might result in a high demand of feed. To meet the feed required in a sustainable manner may be a challenge in food-fuel-feed compares, problem of land degradation, problem of water shortage, biodiversity loss among others. increase demand for available feed resources and the enlargement of the feed resource base, mostly looking at those feed resources that do not compete with human food (FAO, 2015) reported that if humans can make use of such nonfood parts from agricultural materials and products as animals feed, will enhance and increase food security, and also contribute to alleviate environmental problems that associate with their disposal, that hugely contribute to environmental and water pollution.

Wastes are materials that may no longer be needed but may become food or feed stock or raw material elsewhere. Very huge consumption in the nearest future might result in a high demand of feed. To meet the feed required in a sustainable manner may be a

challenge in food-fuel-feed compares, problem of land degradation, problem of water shortage, biodiversity loss among others. increase demand for available feed resources and the enlargement of the feed resource base, mostly looking at those feed resources that do not compete with human food (FAO, 2015) reported that if humans can make use of such nonfood parts from agricultural materials and products as animals feed, will enhance and increase food security, and also contribute to alleviate environmental problems that associate with their disposal, that hugely contribute to environmental and water pollution. Maize (*Zea mays*) husks are waste materials that majorly constitute environmental pollution due to its seasonal large amount of consumption worldwide.

To continuously have regular supply of such waste materials to feed livestock, farmers have to consider cultivating maize in large amount, thereby increasing its commercial purposes would enable farmers have sales of maize for human's consumption, while farmers are liable to earn additional income by selling such by-products from maize. Maize could be considered the third very most important cereal crop all over the world. it is possible to grow both in tropical and temperate regions of the world because it has its grain utility as source nutrient for humans and animals including livestock, (FAO, 2010). After the harvest, the husk is normally discarded as waste, and it is most times simply left to rot or burnt in waste bins. Burning of maize husk poses health and environmental hazards, as the smoke released during the process is irritating to the eyes and the smell from the burning husk induces difficulty in breathing.

When dumped along roadside during the wet season, the heaps become an eyesore, decomposing very slowly and persist for a long time, thereby constituting nuisance to the environment. Most times, flood and erosion transport such waste to block water channels

like underground drainage systems. Millions of tons of maize husks are produced annually in Benin City and other parts of Nigeria. The husks so produced have posed serious threat to the environment in most cases. Hence, using the maize husks as feed for animals and livestock will be of great importance to humans and environment.

Maize (*Zea mays*) belongs to the Family of Poaceae, monocot plant, an angiosperm with large economic value, importance and uses as foodstuff and alternative source of energy. Gibson, (2002) clearly reported that maize (*Zea mays*) wastes are eaten both in raw and cooked forms and it is a special delicacy. Most countries produce and export maize for business and commercial purposes. Major maize-exporting nations, such as India. While most other regions are also involved in the importation of maize for example, the United States of America, most European countries and some Asia countries. The maize husk is classified as waste material and a source of environmental pollutant, to have a large harvest and a regular supply of these wastes for livestock feeding, farmers could think and consider cultivating maize (*Zea mays*) in large amount to increase it harvest voluminously. Besides maize is selling for human consumption, farmers are liable to having additional income by selling these by-products and wastes from maize plant as reported by Badeshi (2012).

The maize husks are mainly residue constituent in the maize commercialization in market for consumption purpose in homes and in the industrialization. Maize as by-products is capable or liable to add nutritional value to other raw materials and contribute to a sustainable development, thus protecting the environment. It could reliably constitute other cellulose-rich agricultural residues and wastes. Production of nanomaterial are possible from the bio-polymers gotten from agricultural wastes for example, rice straw,

maize and coconut husks that are available locally in countries to be used as an application with or to reinforce as filler material and product in bio plastic industries as duly reported by John (2008), and Thomas (2010). Maize husk can equally be used for paper production because it has fibrillar cellulose; it is also a potential source for pulp that has a little environmental threats and degradation when it's compared to wood as well established by Fagbemigun *et al*, (2014).

Kohajdova *et al*, (2012) also contributes that maize husk can be applied and used as source of functional 'food additives and ingredients' because it's fibre-rich by-products and of dietary fibre. Basanta *et al*, (2014) contribution was that these can be added in food materials and products as inexpensive, low-caloric bulking agents for partial replacement of flour, sugar, or fat as enhancers of oil and water retention and to improve emulsion or oxidative stabilities, Eucuch, (2011) additionally said that maize husk is capable to give rise to enzymatic functional oligosaccharides. Most cities in Nigeria are environmentally polluted, such pollution occurs during maize harvest season because the streets and roads are littered with roughages such as husks, stover, peels, and haulms amongst others. These serve as major environmental pollutants; such are carried by flood from the road side and transported into drains and drainages thereby leading to blockage. Maize production in Nigeria stood at 10.5 million metric tons as reported in 2016 and 2017 by (FAO, 2017). They are cheap, readily available and can serve as suitable energy, and high protein.

1.1 Justification for the Study

The purpose of the study was to view, analyze and interpret solid waste generation, disposal methods and environmental impacts associated with solid waste management. The conversion of maize (*Zea mays*) husks wastes as animal feed in Benin City Oredo metropolis were chosen because it was part of the state that was faced with problems of waste management. Secondly because of the rapid growth of human settlement and the inflow of human activities in the City Centre for business, academics, and job among others that leads to increase in population.

1.2 Aim and Objectives of the Study

The aim of the study was to analyze the solid waste generation, disposal, management and the environmental challenges associated with the management of solid waste in Oredo LGA and conversion of maize (*Zea mays*) husks wastes as animal feed in the study area.

The objectives of the study were to:

1. determine the demographic characteristics of respondents, and the methods of waste generation in the study area;
2. determine waste disposal mechanism, methods and identify factors that influence solid waste management practices in Oredo LGA;
3. determine practice of waste recycling and management in the study area; and
4. determine the nutrient content of maize (*Zea mays*) husks as potential animal feed.

CHAPTER TWO

LITERATURE REVIEW

Solid waste management (SWM) is the management process of solid waste - generation, collection, transportation, recovery, and disposal in the best applicable or suitable ways and manner (policy and technology) to ensure that public health, socioeconomic, aesthetic and environmental values are not mismanaged and jeopardized as reported by Daskalopoulos *et al*, (1999). Wastes are materials that are disposed of or are required to be disposed of according to the provision and guideline of the national rules and regulations. Miller (1994) states and defined solid waste as an unwanted or discarded materials which is not liquid or gaseous. It might not generally be accepted that solid wastes are useless, unwanted or discarded (undesirable) materials given the degree of scavenging on pileup waste heaps in developing nations like it was observed in Nigeria. Wastes are those materials in the city centers produced, used and cannot be reused and are thrown out into the environment. Such materials can be valuably used in form of raw materials located in wrong places (Sharma, 2010).

Allende (2009) considered waste as problems of humans that are of most interest and concern to the whole world. That problem of waste management is a huge challenge to city planners and urban-developers all over the world. That the problem is bedeviling most developing countries with increase in population, and poor planning which lack adequate resources in addition to the poor state of waste management.

Solid wastes have direct and indirect impact on environment and life. The direct effects are the impact on animal and plant life and the effects on human health and the

environment. The indirect impacts are mostly long-term such as climate change and ecosystem pollution that may have a significant impact on some part of the world, because people in those areas depend on some of the natural systems for survival Woodwell (1970). Unacceptable waste disposal leads to unsanitary/unhealthy environmental conditions that are detrimental to human health. In situations where sanitary facilities, such as toilets, do not exist or are inadequate, the health situation becomes exacerbated, worse and in bad situation when human faces are mixed with discarded waste (Kjellen, 2001). Thus, better management of municipal solid waste is liable to profoundly solve problems of greenhouse gas emissions as reported by (EEA, 2011).

Decades ago, the rapid increase of economic activities and population in the developing countries has led to exponential increase in consumption of natural resources that has caused much waste generation in most parts. Due to insufficient and lack of human and financial capacities with strength to solve the situation, unacceptable waste disposal has been a challenge in developing countries, including Nigeria in Africa. Almost 20 to 80 percent of the solid waste in African cities is disposed of by dumping in open spaces, water bodies, and surface drains as a result of inadequate infrastructure and awareness. Municipal waste should be properly disposed and manage to safeguard human health and the environment including the preservation of natural resources as reported by (United Nations Environment Programme, 1999).

2.1 Functional Elements of Waste Management

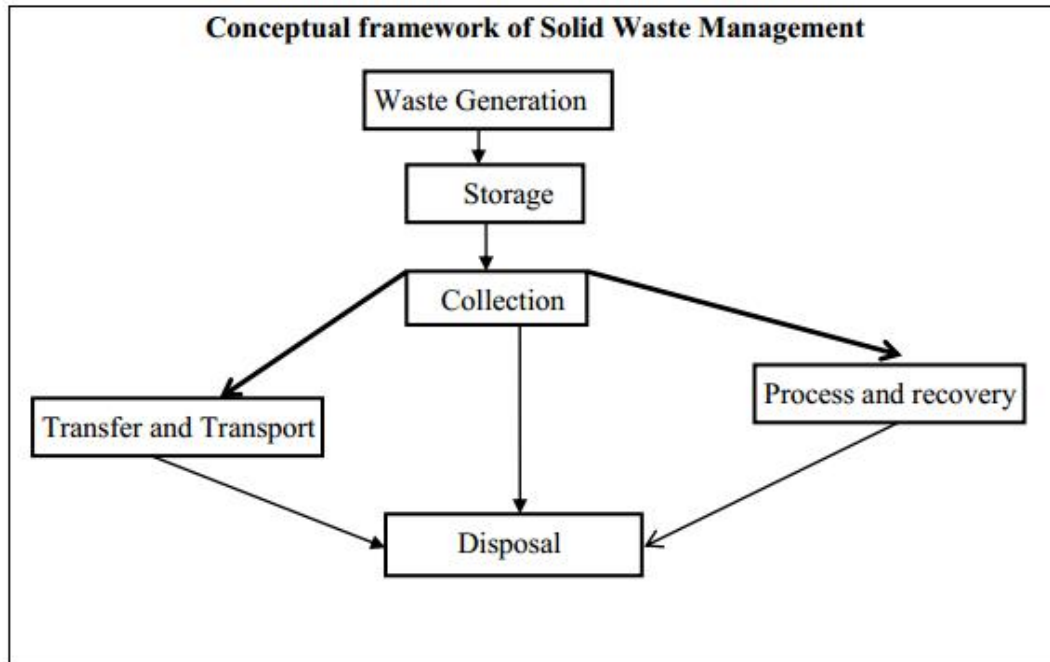


Figure 2.1: Relationship of functional elements of waste management

2.1.1 Waste generation. This involves and encompasses activities in which materials are identified as not useful, without an interest to be reused and disposed. The volume that generally makeup waste materials already combined and generated is so valued in operational system of solid waste management Daskalopoulos *et al*, (1999).

2.1.2 Waste Processing and Storage. The processing, handling and storage of waste that is close to the point of generation. The storage of waste helps to keep facilities when they are discarded ‘prior to collection and final disposal.’ Waste storage equipment must be available where the public can use them easily Sharma (2010). To improve equipment for storage materials such as household container, waste bins, pits holes, local/communal depots are to be provided appropriately.

2.1.3 Collection of Waste. Things that have to do with gathering of solid wastes and the carrying of wastes to a place where the collection vehicle is positioned emptied the removal of waste from the main storage point of the first generation to the final place of disposal or deport Daskalopoulos *et al*, (1999).

2.1.4 Transport and Transfer of Waste. Are things that have to do with transfer of waste, solid wastes are normally transferred from the smaller collection unit/vehicle to the larger transport equipment and again the later/subsequent transport of the wastes through a distance to the final dumpsites Daskalopoulos *et al*, (1999). These are considered in choosing a suitable/reliable vehicle to use; rates of solid waste production/generation, number of people in the area which is population density, community land mass that is accessible with distance in waste collection and disposal of waste.

2.1.5 Collection/disposal of Waste. These are activities involved with the disposal of solid wastes materials, such as waste collection/transportation straight to the appropriate places like landfill, dumps, (sludge) among others. The choice of waste collection method is of importance because waste collection is shown to comprise 50- 75% of the total MSW management costs as reported by (Breeze, 2012). The public authorities are eventually and consequently looking for a new method to organize solid waste collection and improve performance to reduce waste generation.

Carefully estimate volume of waste collected and interval of collection. These are two core functional factors that ensure proper solid waste management in the city. If not carefully estimated, can lead to improper, and mismanaged transfer or transport of waste,

which can disrupt the entire system of solid waste management. On the other part, functional element of collection (FEC) of solid waste includes not just the gathering of waste and materials that are recyclables also involves the transport of such wastes after collection, to the final location. Such location could be a factory where materials are processed. Separation of waste associated with waste management before the wastes are properly placed in storage containers before collection. Waste handling includes the movement of parking, carrying and moving containers already loaded to the point of collection (Breeze, 2012). An important step is the separation techniques of waste components during handling and storage of solid waste after generation.

2.1.6 Sorting of Waste and pickup. There are different ways to describe solid waste, we have compound or yard waste like grasses, clippings like things that are easily cut in the compound and other dirt like unused mulches are technically known as solid waste Buclet and Olivier, (2000). It is therefore a regular trash that one might just throw away like spoil food or paper. Heavy paper-based products like cardboard and newspapers are recyclables also known as solid waste. Sorting the waste by type is the first step in the collection process and select what will and what will not be disposed Lawal *et al*, (2010). After sorting by the residents putting it in the appropriate waste bin and before collection.

Different means to pick up waste, trash baskets of different types can be placed at different locations at home, and garbage collectors can go house to house to pick them up. Communal waste/trash bins is another type in some apartment, as well as county recycling containers for glasses, plastics, paper and other organic wastes. Harzardous waste like syringes and other sharp objects are specially recycled. The waste is taken from all of these sites on a schedule and then transported to a final destination, (Buclet and

Olivier, 2000) in their work reported that waste collection methods vary widely among different countries and regions. They states that the household waste collection activities /services are often rendered by local government councils, or by private bodies like NGO in the industries. Mostly in some area like developing countries, might not have a formal functional waste-collection system.

Solid waste management is one of the essential services provided by government authorities in the country to keep cities clean. Thus, it is among the most poorly rendered services in the basket, the systems applied are outdated, not efficient, and not scientific; population coverage is low; and the poor are marginalized. Waste is littered everywhere thereby leading to insanitary living conditions. Government rules and regulation on the rural and urban lacks adequate provisions facilities to work efficiently among the ever growing issues that concerns waste management. The situation is worse due to large population, human migration, development among others.

Waste management and practice are differently practice with different techniques for developed and developing nations, including urban and rural communities, both in residential and industrial regions. The non-hazardous management of residential and institutional wastes in major cities are responsibility of local government councils, non-hazardous commercial and industrial waste are managed is usually by the producer subject to local, national or international.

Solid waste management can always be viewed as the volume of waste produced and generated in a given area and how it is being collected, transferred, disposed or make use of or utilized in cities, towns and institutions, with efficient arrangements put in place for

the efficient waste disposal management (Ogu, 2000). Basically, solid waste management has been a major challenge in Nigeria especially since post-independence era. This is just because solid waste generation has consistently expanded in huge amount, volume, and in complexity. Expansion in solid waste generation is due to the rapid increase and growth in population over the year, massive economic development, industrialization, technological advancement, change in life style, mode of consumption and patterns. Sadly, such development has not been matched or compared by adequate provision and funding, and infrastructural facilities to sustainably manage such ever growing huge amount of waste. As a result, this has led to a poor, ugly and worse state of our environment because all kind and manner of waste dust our drainage, scattered everywhere in our street, market places and open places according to Isu (2005), reported that indiscriminate disposal of waste is a menace, threat, embarrassment, danger to nation in general and state in particular where wastes are spread in public places.

Rapid urbanization in twentieth century has transformed the world into communities of cities and a town that is now facing same issues on environmental challenges, most of them have been tackled internationally Uchegbu (1998), viewed that solid waste management is a major issue among such environmental problems, because of the involvement of human activities, that avoidance of solid waste generation could not be avoided in developing and developed countries. Therefore, solid waste management became worldwide agenda as united nation conference on environmental and development in Rio de janeirio in 1992 with a very great emphasis on reducing waste and maximizing environmentally sound waste reuse and recycling at first step in waste management (UNEP, 1996) as cited in Seadon (2006). Therefore, management of solid

waste is known as the discipline in control of the generation, storage, collection, transportation, treatment and disposal of the waste in a manner that is in accordance with the best practice principle of public health, economic, engineering, conservation, aesthetic and other consideration in the environment. If waste is left uncollected, it can constitute very serious health hazard in local places, it was reported that leachate generated from abandoned and decomposed waste or garbage can pollute underground water “(UNCHS, 1988) and can lead to unusual health implications mostly in low-income communities that uses well water for drinking purpose.

Solid waste management also includes administrative, financial, planning, engineering and environmental consideration according to (Akolkar, 2005). The terms (solid waste management) relate to things and materials produced by human activities and some processes to reduce their effect on environment and health. Municipal solid waste management means systemic control of generation, collection, storage, transport, source separation, processing, recovering and disposal of solid waste in a way that is in accordance with the best rules and regulation of public health, economic, engineering, conservation, and aesthetics, with environmental considerations that are responding to public attitudes or awareness by Techobanoglous (1993).

Solid waste management has faced with numerous challenges, such as solid waste transportation so expensive, it is a capital and labour intensive. Oredo LGA solid waste directly affects the public, the face of the city, and the citizens’ day by day lifestyle and activities. Considerable percentage of urban waste in most developing countries are directly deposited on the road sides, unapproved dumpsites, on water ways, drainage system, and open spaces adversely affect environmental friendliness, (Kalu, 2009).

Unlawful activities in waste management not only threatening ways of life, the natural flow of water bodies, forest reserves, diversity-rich mountains and beaches including cities and villages. Littering spoils/deface the natural scenic beauty of the environment. Scientific report by Momoh and Oladebeye, (2010) said that exposure/vulnerability of pollution of surface and groundwater is very high just because local authorities hardly/rarely consider environmental impact in setting solid waste disposal sites. That indiscriminate dumping of household waste in our streets, water bodies, drainage, flooded roads and the spread of offensive odour and diseases also poses environmental threats on nearby properties. Momoh and Oladebeye, (2010) observed that scavenging, privatization, or treating environmental problems of waste disposal, and institutional capacity building are the existing critical dimensions in the management of solid waste. Those cleaner cities are liable to attracting private investments and tourists, and therefore create more jobs in the locality. For economic to be prospering, there should be flow in investment to attract more revenue to government, thus work and services to satisfy its citizens in the community.

Numerous work and studies on (MSW) have showed that sources separation with collection and by reuse and recycling of materials, the non-organic products, fertilizer production through organic waste fraction and anaerobic digestion to be an alternatives choice to landfill disposal of waste as reported by Momoh and Oladebeye, (2010). Remigios (2010) is of the view that open dumps are the preferred method of disposing of solid waste as an alternative of landfills in most African countries, in Nigeria most landfills are open dumps. Treatment and Disposal of Solid Waste: Waste treatment and disposal is known to be activities that ensured that the waste has the least impact on

health and environment. Waste treatments are needed via rules and regulation available in countries at different rate. The importance of treatment of wastes can never be overemphasized and in waste management, it is a major component and in the hierarchy of waste management, treatments are categorized.

Hierarchy and management of waste are processes engaged to manage and keep the environment safe, also to conserve and protect resources via a prioritized methodology, policy, legislation of waste. The hierarchy enables the creation of choices of activities prioritized base on sustainability level. For management of waste to be sustainable, it should not be based on technical and “end-of-pipe solutions” and an integrated approach/method is necessary and required.

Hierarchy of management of waste gives the order of preference to manage and reduce waste generation, and it has diagrammatic presentation in a pyramid form. The hierarchy presents/features the materials in a progression format in all successive stages of waste management, and represents the latter part of the life-cycle for each product.

The aim of the waste management Hierarchy of the management of waste is aimed to maintain higher level of benefits from products and to produce lesser waste Momoh and Oladebeye, (2010). The best method of application comes with much benefit. It helps prevent greenhouse gases emission; it helps lower environmental pollution and pollutants, energy conservation, resource conservation, jobs creation, development of green technologies to stimulate development.

2.2 The Waste Hierarchy

The management of waste is ranked based on options in accordance to environmental best practices. It renders knowledge on ways to prevent waste generation. Reduction in waste generation can eventually reduce waste disposal. When little or lesser waste is generated, it gives room for the management via reuse, recycling, recovery, and disposal very easier.

2.2.1 Waste Prevention: It brings about the avoidance and reduction of waste generation; this is an integral part of waste hierarchy. Prevention helps to minimize production of waste materials. As usual prevention results the least “economic and environmental life cycle costs” due to the requirement of avoidable collection/process of items Remigios (2010). There will be significant benefits and efficiency in the use of resources due to prevention. It also the reduction of items in design, production and makeup, to keep materials and conservation of less hazard items.

2.2.2 Waste Reuse: This is another desirable option, of items and products that can gainfully be useful for the make of another material. To reuse materials involves the reduction to a smaller in size and needs no going through making, because it requires cleaning, check, repairs processes to refurbish the items/parts (Kassim & Ali, 2006).

2.3.3 Waste Recycling: It involves activities to collecting, retrieval of materials and separates them in different segments according to their makes. In the process they can be categorized as reused after recycled while the unused items has to be discarded and throwaway, that would otherwise be considered waste. (Kassim & Ali 2006). The process that involves sorting and processing the recyclable items into new items is known as

recycling and then re-manufacturing materials from the already recycled products into new items.

2.2.4 Waste Recovery: Waste is recovered in a way to again separate waste in classes it involves energy recovery with materials. Either of them can be useful in health and the environment as an option. Materials recovery mostly an option because of its activities that is directly affects compost and recycling. Such waste needed to involve whatever it takes to manage waste collection, to process and to convert to fresh items/products Remigios (2010). Incineration is usually the last option to consider in energy recovery, because the processes involve heat generation. Electricity can be generated from non-recyclable materials, with the involvement of many processes fuel, with aerobic digestion, pyrolysis and even gasification.

2.2.5 Waste Disposal: Lastly, disposal is least or less option and it is accepted when other options are taken. Disposal is mainly known as dumping and waste incineration with no recovery of energy. Even pre-treatment may be considered before waste is finally disposed, just to change features of the waste to enable reduction of the volume and effects including physical, thermal, chemical, or biological processes. The most commonly considered option might be landfill form of disposal Cointreau (1983).

Major Issues in developing countries, it is very common for local councils to spend 20-50 percent of their recurrent budget on solid waste management according to (Holmes, 1984). But still common that 30-60 % of the city's solid wastes in countries that is developing are not collected, less than 50 % inhabitants are served. Just because 80 percent of waste management equipment lack usage for lack of maintenance and repair.

2.3 Overview of Management of Solid Waste

Management of solid waste is a huge challenge for the city authorities in developing countries mainly because there is increase in the generation of waste and it has been a burden on the local budget due to high costs associated with its management. Dewees (1998) is of the view that lack of understanding over numerous factors that affect the different stages of waste management and factors necessary to enable the entire handling system, and processes function. Management of solid waste is defined as the discipline associated with control of generation, storage, collection, transfer and transport, processing and disposal of solid waste in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetic and other environmental consideration, that is also responsive to public attitudes.

Management of solid waste includes all legal, financial, administrative, planning and engineering functions and processes involved to problems of solid wastes. The solution results may be complex interdisciplinary in relationships in the field like political science, city and regional planning, geography, economics, public health, sociology, demography, communication and even conservation as well as engineering and material sciences according to (Cunningham, 2006).

Solid waste collections are primary, secondary and direct collection system that is prevails most developing nations. The primary collection is known as individual household's method to place raw solid waste into their different personal waste baskets. The secondary collection is known as the collection of solid waste from waste baskets before it's taken to the transfer station, dumpsite or landfill. The direct collection of raw

solid waste from households by the collection vehicles of solid waste management thereafter transported to dumpsite. Many developing nations used their budget on waste management in collection systems but yet still cannot collect the whole solid waste generated. Some of the developed countries have well organized solid waste management. Collection waste bins are provided to collect municipal solid waste. Wastes are disposed in different colored waste bins and are placed appropriately for different types of waste materials as said by (Cointreau, 1983).

Recyclable materials such as glasses, plastics, bottles etc. are provided with waste collection bins and baskets to the local communities to keep wastes, which are later removed and used by recycling industries, such collection techniques are majorly used in developed countries, (Kassim & Ali, 2006). Wastes from individual houses are kept in waste baskets, curbstones, waste bins with different colors placed outside houses. Such wastes are later picked up by waste management vehicles, are single compartment and multi compartment made to separately collect recyclables waste materials. The waste collection, management system and techniques are divided into primary and secondary. A primary waste collection techniques and system are used to collect waste materials from individual houses and put or taken to community waste collection container. Ishengoma 2000, advice that the primary waste collection and management equipment are maintainable and easy to operates, such are tricycles which are driven by humans. Such equipment is enclosed from all sides to prevent waste from falling and littering the street. The collected wastes by primary collectors are deposited in waste bins, for use and in conjunction with compactor trucks. The primary and secondary waste collection and management system are carried out by small mechanical vehicles, trucks. These

collection vehicles collect solid waste from community collection centers, wastes from street corners (Cointreau and Sandra, 1994). Solid waste collection is also done using tractor.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study was carried out in Oredo Local Government Area of Edo State, Nigeria. Oredo is in the south-south geopolitical region of Edo State which in turn is in the south-south geopolitical region of Nigeria. The population of the study area as at year 2006 was 428,650 (National Population Commission 2006). Oredo has the highest concentration and number of inhabitants due to rapid development and urbanization as a result of major Federal and State Government establishments located in the council area, such as the Federal Airport Authority of Nigeria, the State House of Assembly, the State Central and Edo Specialist Hospital, the State Civil Service Secretariat, the popular Oba market, Ogba Biological Garden, Central Secretariat, the State Police Headquarters, the popular Stella Obasanjo Hospital, and the Assistant Inspector General of Police.

Oredo is the commercial nerve of Benin City with features of big and small markets that brought about pileup of waste located around market surroundings. Because there was no adequate awareness, education, including training on the inhabitants in this commercial nerve where sales and buying activities are mostly located, without environmentally friendly manners, lack of environmental science awareness contributed to the pileup of solid waste located in market places, schools, and roads.

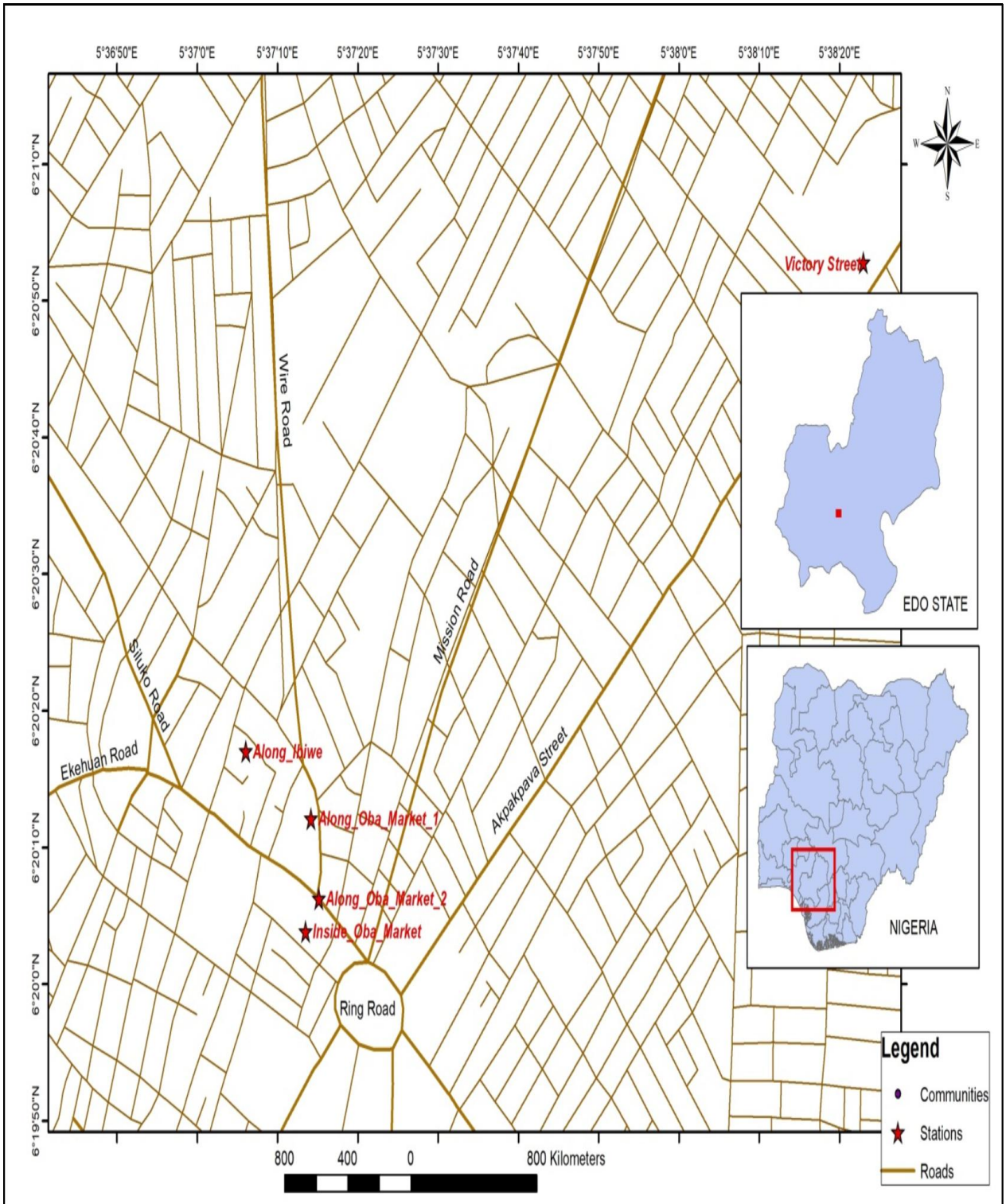


Figure.3.1: Map of Oredo LGA. Edo State and Nigeria.

3.2 Site Description

The study was carried out in Benin City, “Oredo” with an average rainfall of 2000 mm (Akintola, 1986), with minimum and maximum temperatures of 18 °C and 32 °C , respectively, and the assessment of rainfall variability was also viewed by Akinbobola (2019). Illegal dumpsites are located along the major streets and roads in the metropolis as shown in plates below, including moats, roadside, markets, gutters among others. Some of the illegal sites were visited for photographic identification. The visit revealed the illegal activities taking place at some of the illegal dumpsites, such as activities of human scavengers at the dumpsites which could not be photographed for security reasons. Like other cities, Benin city is not left out of most other developing countries, as much pile up of huge number of wastes are not removed from streets, roads, thereby blocking drainage, making breeding sites for disease vectors and spreading diseases with uncountable related, environment and infrastructural problems.



Plate 3.1: Illegal Dumpsite Around Second Junction by New Lagos Rd, Victory Str.



Plate 3.2: Illegal Dumpsite Located Around Ikpoba Slop, Victory Str Area.



Plate 3.3: Illegal Dumps Along Oba Market Road



Plate 3.4: Illegal Dumps Along Oba Market Opp Bob Izua Motor Park.



Plate 3.5: Solid Wastes Removed from Gutter and abandoned at Oba Market.



Plate 3.6: Illegal Dumpsite at Victory Street, New Benin.



Plate 3.7: Illegal Dumps Behind Victory Street.



Plate 3.8: Illegal Dumpsite Located at Ikpoba Slop.



Plate 3.9: Illegal Dumpsite Around Slop and Victory Street.



Plate 3.10: An Illegal Dumps Behind Victory Street, New Benin Market.



Plate 3.11: Illegal Dumpsite at New Benin Market by Victory.



Plate 3.12: Illegal Dumpsite at Victory Street, New Benin.



Plate 3.13: Illegal Dumpsite Behind Ikpoba Slope and Victory road.



Plate 3.14: Illegal Dumpsite Located at Ikpoba Slop.

3.3 Materials and Methods

Firsthand source of information and primary source of data were oral interviews of selected residents, in most parts of Oredo LGA metropolis where public wastes were most commonly seen. Inhabitants and residents were interviewed randomly on important aspects and problems of public waste, including method of generation, mode of disposal, recycling methods, environmental impacts and management. Secondly, field visitation, observation of dumpsites and the environmental issues in the study area, photographs of the waste heaps of different wastes were taken at various locations.

Secondary sources of information and data were from online published materials. Data were gathered from field surveys and observations, questionnaires and desktop information from published materials. The questionnaires were randomly distributed to household inhabitants who live in the selected locations.

3.4 Data Collection and Methods

1. Observation, field trip with observation and interviews.
2. Distribution of questionnaires to respondents.
3. Collection of Maize (*Zea mays*) Husk wastes.

Proximate tests for nutritional value in maize (*Zea mays*) husk wastes specimen were determined using the oven dried method described by Fabiyi and Hamidu (2011), Illeleji *et al* (2010), and Willson and Pearson (1976) respectively.

The questionnaires were distributed and retrieved by hand. Six hundred (600) copies of questionnaires were randomly distributed, but four hundred (400) copies were collected

and retrieved from the inhabitants. Field work and questionnaires helped in having firsthand information. Questionnaires were distributed and retrieved between January to September 2024. Distribution of the questionnaires was carried out 2-3 days in a week, within the period of studies. The questionnaires focused on demographic characteristics of respondents, generation of waste, disposal, management, and recycling. Ethics were also observed, such as willingness, confidentiality of individual information in the interview was observed carefully.

Most of the dumpsites were frequently used for disposal of domestic and household nonhazardous waste, but mainly kitchen waste from living and residential, including market wastes and office waste such as papers, textiles, food plastics, robbers, metals, glasses, woods etc. Most of the illegal dumpsites are influenced or changed by rainfall, which might cause water pollution due to infiltration of leachate produced by the decomposition of the waste in the open dumps, (Plate3.9). Expected groundwater pollution calls for attention, since it is the only source of water available for most inhabitants in the area. Polluted groundwater sources might adversely affect public health and lead to disease outbreak if not properly addressed.

Maize (*Zea mays*) husks both fresh and boiled were collected from a roadside seller, taken to the laboratory of the Department of Pharmacognosy, Faculty of pharmacy, University of Benin, Benin City. The samples were cut and sliced to size and air dried for about two weeks on different table top in the month of September 2024, after which the samples were differently milled into powdered form. However, samples were taken to Benin-Owena Laboratory for further examination and proximate analysis to further test for nutritional values of the (*Zea mays*) husks wastes.

3.5 Moisture Content Determination

Moisture content of each of maize (*Zea mays*) husk waste specimen was determined by the use of oven dry method as described by Fabiyi and Hamidu (2011). A clean crucible was weighed, 5 g of corn cob sample was added and weighed before it was placed in an oven dryer at 105 °C for an hour, and the crucible was removed from the oven and placed in a desiccator to cool. Crucible was removed from desiccator and the weight was taken. While the process was repeated in another 30 minutes, until a constant weight was achieved. The weight differences indicate the moisture content, as calculated thus;

$$\text{Moisture content (\%)} = \frac{M_w - M_o}{M_o} \times 100\%$$

3.6 Fat Content Determination

Fat content was determined by the use of Soxhlet extraction method used by Illeleji *et al* (2010). Where a Soxhlet extractor and a reflux condenser with a 500 ml round bottom flask was fixed. 2 g of maize (*Zea mays*) husks sample was weighed into a thimble, with 300 ml of petroleum ether was filled into the round bottom flask. The extraction thimble was sealed with cotton wool, the complete assembled Soxhlet apparatus was allowed to reflux for about 6 hours, before the thimble was carefully removed, and the petroleum ether evaporated into the container for reuse. When the flask was free of ether it was dried at 105 °C for an hour in an oven, cooled in a desiccator and weighed, the percentage

fat content was calculated thus: % Fat = $\frac{(W_2 - W_1) \times 100}{S}$

3.7 Ash Content Determination

The method used to determine ash content was professionally used by Illeleji *et al* (2010). A clean dried crucible was weighed, five grams (5 g) of the maize (*Zea mays*) husk sample was added and reweighed, and the crucible was placed in the muffle furnace at 550°C for 4 hours until a light grey ash was obtained. The muffle furnace was turned off and allowed to cool to room temperature before removal. It was then cooled in a desiccator, weighed and the ash content was calculated as:

$$\% \text{Ash} = \left(\frac{\text{Weight of Ash}}{\text{Weight of Sample}} \right) \times 100$$

3.8 Protein of Non-Fat Extract (NFE)

It is termed crude protein because nitrogen is used as an index of the protein because it represents all nitrogen that is in form of non-protein nitrogen (NPN) for example, nitrate, ammonia, urea and single amino acids, as well as nitrogen present as true protein. The multiplication by a conversion factor of 6.25 is based on the assumption that true protein contains 16% nitrogen. The micro-Kjedahl method of digestion described in Wilson and Pearson (1976) were used. Where one gram (1g) of maize (*Zea mays*) husk was digested in Kjedahl digesting system, the digested sample was cooled and distilled into a flask containing 5ml of 2% boric acid solution and few drops of methyl red indicator and diluted with distilled water, followed by the addition 60% of NaCl solution. The distilled sample was then titrated against 0.1M HCl solution. A blank titration was equally carried out and the content was estimated as percentage nitrogen was calculated as: % NFE = 100 – (% Moisture Nitrogen + % Crude Protein + % Ether Extract + % Crude Fiber + % Ash).

3.9 Determination of None Fat Extract (NFE)

Soluble carbohydrates were represented by Non-Fat Extract (NFE), crude fiber and other digestible and easily utilizable non-nitrogenous substances. The total NFE was determined by mathematical calculations, it is the difference obtained by subtracting the sum of all the nutrients already determined from 100. Where $\% \text{ NFE} = 100 - (\% \text{ moisture} + \% \text{ Crude Protein} + \% \text{ Fat Extract} + \% \text{ Crude Fiber} + \% \text{ Ash})$.

3.10 Statistical Data Analysis

The data and information gathered were subjected to statistical analysis using charts for qualitative variables. Test for Educational Level and Awareness of Recycling were carried out using the chi-Square contingency table analysis (Ogbeibu, 2014). All analyses were carried out using the SPSS 20.0 computer programme.

CHAPTER FOUR

RESULTS

This chapter presents the analysis of data collected from 400 respondents in Oredo LGA, Edo State. The findings are structured to address the study's objectives: assessing demographic characteristics, examining waste disposal mechanisms, evaluating recycling practices, and exploring environmental challenges. The commonly seen features that welcome visitors in most major streets of Benin City are mountainous huge pileup of solid waste dumpsites. Such huge heaps of solid wastes in most parts have make up mountains can be seen in places like Oba Market, Ring Road, Victory Street. Such solid waste dumpsites were located on major streets at different locations as shown on plates 1 – 14.

4.1 Demographic Characteristics of Respondents

The data reveals an almost equal gender distribution among respondents, with 49.5% males and 50.5% females (Table4.1). Most respondents fall within the age group of 50-59years (29.5%), indicating an adult population. Regarding education, the majority have attained high school education (29.5%), followed by middle school (20.5%), reflecting a moderately educated community.

Table 4.1: Demographic Characteristics

Characteristic	Frequency	Percentage (%)
Sex		
Male	198	49.5
Female	202	50.5
Age Group		
15-17	6	1.5
18-29	10	2.5
30-39	42	10.5
40-49	44	11
50-59	118	29.5
60-64	102	25.5
65 and over	78	19.5
Educational Level		
Never Schooled	38	9.5
Primary	62	15.5
Middle School	82	20.5
High School	118	29.5
University Graduate	80	20
Vocational Training	20	5

Table 4.2: Types of Waste Generated in the Study Area

Type of Waste	Frequency	Percentage (%)
Food Waste	160	40
Plastics	120	30
Paper	72	18
Cans	32	8
Others	16	4



Figure.4.1 Types of Waste Generated in Oredo LGA, Edo State

Table 4.3: Waste Disposal Methods in the Study Area

Disposal Method	Frequency	Percentage (%)
Public Bin	115	28.75
Itinerant Waste Van	85	21.25
Roadside Disposal	102	25.5
Open Space	62	15.5
In a Hole	36	9



Figure.4.2 Disposal Methods in the Study Area

Table 4.4: Recycling Awareness and Practices in Oredo LGA, Edo State

Variable	Frequency	Percentage (%)
Aware of Recycling	272	68
Actively Recycling	128	32
Not Recycling	272	68

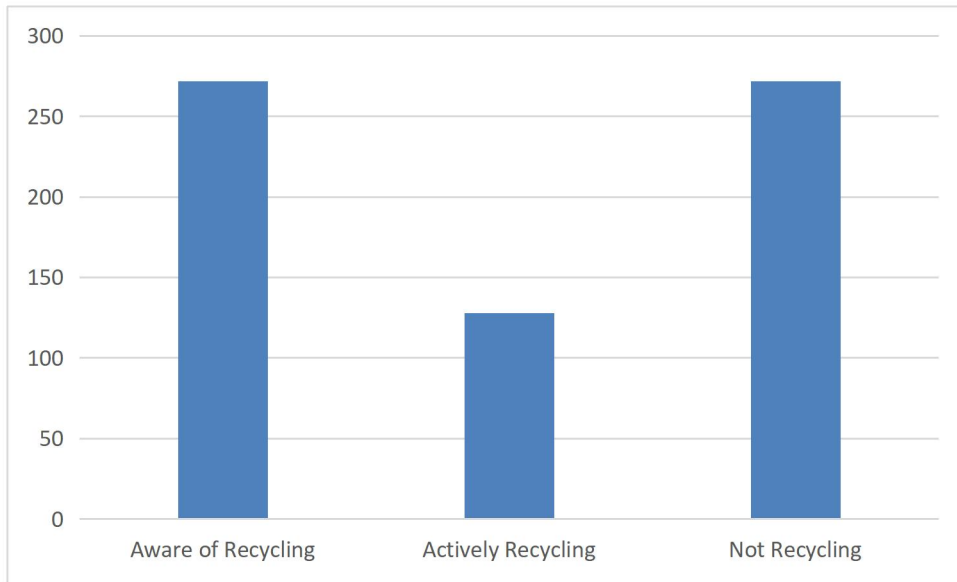


Figure.4.3 Recycling Awareness in the Study Area

**Table 4.5 Environmental Challenges Identified by the Respondents in Oredo LGA,
Edo State**

Challenge	Frequency	Percentage (%)
Environmental Pollution	248	62
Health Hazards	192	48
Presence of Rodents	152	38

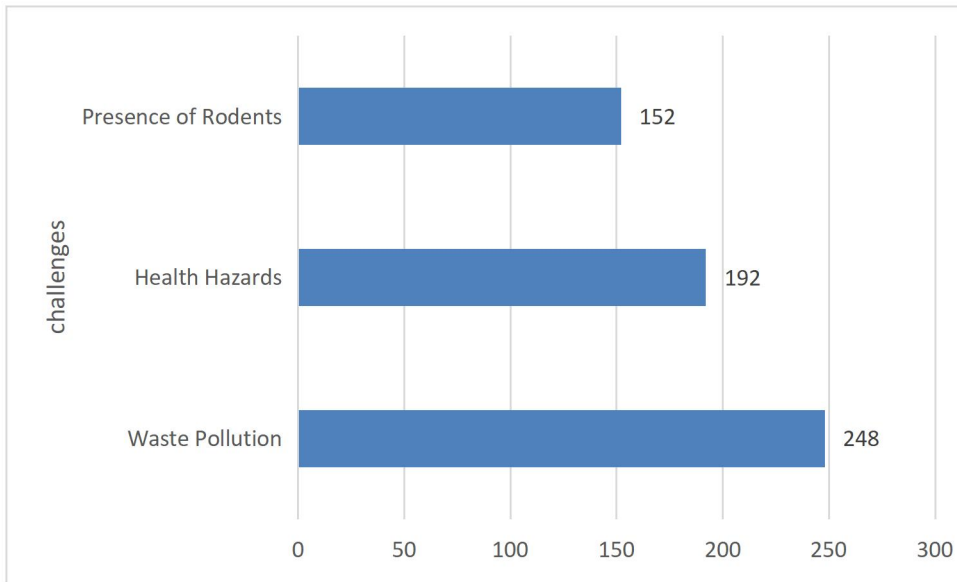


Figure.4.4 Environmental Challenges in the Study Area

Table 4.6: Cross-tabulation of Educational Level and Awareness of Recycling

Educational Level	Aware of Recycling (%)	Not Aware of Recycling (%)	Total (%)
Never Schooled	10 (26.3%)	28 (73.7%)	38 (100%)
Primary School	36 (58.1%)	26 (41.9%)	62 (100%)
Middle School	54 (65.9%)	28 (34.1%)	82 (100%)
High School	98 (83.1%)	20 (16.9%)	118 (100%)
University Graduate	66 (82.5%)	14 (17.5%)	80 (100%)
Vocational Training	8 (40.0%)	12 (60.0%)	20 (100%)
Total	272 (68.0%)	128 (32.0%)	400 (100%)

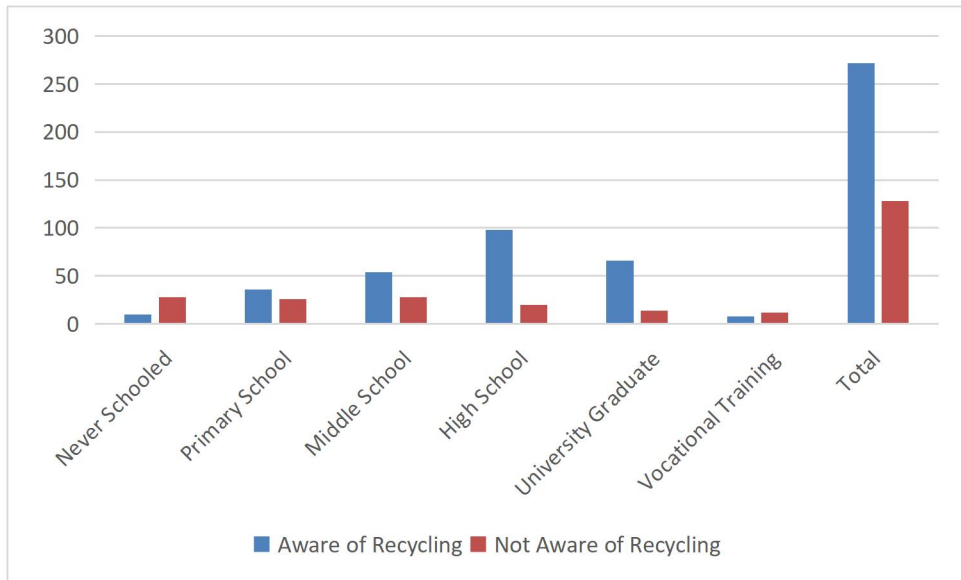


Fig.4.5 Cross-tabulation of Educational Level and Awareness of Recycling in the Study Area

Table 4.7: Chi-Square Test Results for Educational Level and Awareness of Recycling in the Study Area

Statistic	Value	p-Value	Significance Level
Chi-Square Value	16.27	0.012	0.05

4.6 Test for nutritional value of freshly unboiled and boiled maize husks (*Zea mays*).

Table 4.8: Analytes of interest: Proximate analysis.

	Moisture	Crude fat	Crude fibre	Crude protein	Ash content	Carb. (N.F.E)
Boiled maize	2.25	0.00	14.65	4.62	1.97	76.51
Freshly unboiled maize	1.59	0.00	13.87	3.13	1.52	79.89

Concentrations in %

The comparative analysis between boiled and freshly unboiled corn cobs provides insight into their nutritional composition, revealing subtle differences influenced by the boiling process.

4.7 Moisture Content:

The moisture content of the boiled corn cob is slightly higher (2.25%) than that of the freshly unboiled corn cob (1.59%). This increase in moisture is likely due to water absorption during the boiling process. As the corn cob is heated, it absorbs water, which contributes to the higher moisture content in the boiled sample. This difference is small but significant, particularly when considering the preservation and storage of these cobs for various uses.

4.8 Crude Fat:

Both the boiled and freshly unboiled corn cobs show zero crude fat content. This suggests that corn cobs are virtually fat-free, making them a good option for those looking to avoid fat in their diet. The boiling process does not appear to introduce any significant fat content, which is consistent with the general nutritional profile of corn cobs.

4.9 Crude Fibre:

The crude fiber content is higher in the boiled corn cob (14.65%) compared to the freshly unboiled corn cob (13.87%). This slight increase in fiber after boiling may be due to the breakdown of some complex structures during the heating process, which makes the fiber more accessible or alters its composition. This difference, although minor, could have

implications for the digestibility and fiber availability in animals or humans consuming these cobs.

4.10 Crude Protein:

Boiled corn cobs contain more crude protein (4.62%) than the freshly unboiled counterparts (3.13%). The increase in protein content after boiling could be attributed to the concentration of nutrients as water evaporates during the cooking process. Boiling might cause the corn cob to lose some water-soluble components, but the protein, being less susceptible to heat, becomes more concentrated in the boiled cob.

4.11 Ash Content:

The ash content, which represents the mineral content of the corn cob, is also higher in the boiled corn cob (1.97%) than in the freshly unboiled one (1.52%). This increase could be due to the concentration of minerals as water is lost during boiling. The difference is not large, but it indicates that boiling might alter the mineral profile slightly, potentially making certain minerals more available or detectable in the final product.

4.12 Carbohydrates (N.F.E.):

The freshly unboiled corn cob has a higher carbohydrate content (79.89%) compared to the boiled corn cob (76.51%). The reduction in carbohydrates after boiling might result from the breakdown or leaching of sugars and starches into the boiling water. This difference is notable when considering the energy content of the corn cobs, with the freshly unboiled cob potentially offering more readily available carbohydrates for energy.

CHAPTER FIVE

DISCUSSION

5.1 Demographic characteristics/distinguished features of the respondents.

A total number of 600 questionnaires were distributed between January through October 2023 out of which a total of 400 questionnaires were retrieved. The highest number of data respondents reveals an almost equal gender distribution among respondents, with 49.5% males and 50.5% females. Most respondents fall within the age group of 50-59 years (29.5%), indicating an adult population had the highest number of respondents. Regarding education, the majority have attained high school education (29.5%), followed by middle school (20.5%), reflecting a moderately educated community. The findings from this study highlighted several key insights into solid waste management practices in Oredo LGA. Demographically, the youthful and moderately educated population offers an opportunity for targeted interventions to enhance waste management practices.

Solid wastes generation, collection, disposal and management in most parts of Oredo environs are very serious issues because of the environmental problems associated with solid wastes. The study showed that population increase was not controlled, and accredited waste managers are parts of the problems of wastes management. Food waste accounted for the largest proportion of waste generated (40%), followed by plastics (30%). This suggests that biodegradable and recyclable wastes constitute a significant portion of the household waste in the study area. Paper (18%) and cans (8%) also contribute to the waste stream, highlighting the potential for targeted recycling initiatives. The predominant reliance on public bins and roadside disposal underscores the urgent

need for improved waste disposal infrastructure. Environmentally detrimental methods such as open space dumping further exacerbate public health risks.

Recycling awareness, though relatively high (68%), does not translate into active participation (32%), largely due to infrastructural and informational barriers. The cross-tabulation analysis revealed that education plays a significant role in recycling awareness, with higher education levels correlating with increased awareness. This insight emphasizes the importance of integrating educational campaigns into waste management strategies.

Environmental challenges, particularly waste pollution and health hazards, reflect the inadequacies of current waste management systems. Addressing these issues will require a multi-faceted approach, including infrastructure development, policy enforcement, and community engagement. Efforts to improve waste management in Oredo LGA should focus on enhancing waste collection services, promoting recycling through accessible facilities and education, and addressing the environmental and health implications of poor waste practices. These steps are essential to achieving sustainable development in the study area.

Findings from this study also revealed that wastes are not properly managed around the popular King Square, Oba Market, and ring road axis due to the presence of mountainous heaps of waste dumps on the road side. Furthermore, evacuation of waste from the gutter in the Oba market was abandoned for so long in the motor garage within the market. There are outrageous, massive and enormous environmental and health effects on the lives and properties around there. If not properly managed, it might lead to

decomposition and putrefaction thereby polluting land and underground water, when the waste percolates into the underground water resources. The decomposition and breakdown of organic wastes can produce unpleasant odour which is capable of attracting some animals including stray dogs, reptiles, and birds into the heaps of garbage and spread them around, which could lead to unhygienic and unhealthy environment.

The study revealed that illegal activities taking place at some of the illegal dumpsites, such as activities of human scavengers in the dumpsites which included separating reusable materials, contributed to the spread of wastes in the study area. The scavengers did not allow themselves to be photographed for fear of being seen or reported to the authorities.

Consequent on the activities of the scavengers, the sites visited showed evidence of wastes expanding to adjoining areas irrespective of the land use of the area or the immediate intervention in the environs. Results revealed that most respondents were willing to recycle their waste but had no knowledge about it. Since majority lack the idea of recycling, they thus engaged in indiscriminate waste disposal and burning of waste illegally. Some respondents were engaged in the recycling of cans and plastics bottles which they sell at the end of recycling and make some money. Thus, if the government is willing to establish waste recycling centre, respondents will invariably make use of them.

The findings corroborate the view of Ayotamuwo and Gobo (2004) that heaps of wastes located in the centre city of Port Harcourt, in most cases food wastes, papers, textiles, scraps, metals, glasses, polythene bags, and food wastes obstruct traffic on high ways. The current study however indicates that there is much to be done in the case of Oredo in

Benin City with respect to waste management in order to ensure a cleaner environment and achieve sustainable development. Policy makers, stakeholders and authorities in governments have a very huge task to accomplish for a sustainably developed and environmentally safe city.

Improper storing, handling and disposal of waste are the most common causes of environmental pollution as shown in this study, thus providing an enabling environment for pathogenic organisms and aiding the spread of infectious diseases. Field observations also indicate that the cart pushers are still operating secretly despite the official ban against their operations by the state government. Having been banned by the government, they have no place earmarked for them to dump their waste.

Problems associated with waste disposal can be related with absence and lack of commitment to take a very good care and to safeguard lives and properties. Nabegu (2010), Agunwamba (1998), Ayotamuno and Gobo (2000), Oyemiyi (2011), reported that the unclean behavior and habit are mostly practiced in other cities in Nigeria. The reasons are attributed to financial limitation, lack of knowledge and corruption in government. There is need for government to improve workers safety and productivity, which is medically recommended that waste handlers and managers are liable to subject themselves to prophylactic measures to ameliorate irrelevant, unnecessary health challenges as reveals by (Banjo *et al*, 2011).

Oredo LGA has no recycling centre with recycling machines or a plant, recycling is locally carried out by waste scavengers that go from place to place in search of iron scraps, cans, and plastics bottles. Normally jump on the waste collection vehicles to gain

access to recyclable materials as the wastes are being taken to dumps. Scavengers are equally located at illegal dumps and other places where they can locate recyclable materials (Ogwueleka, 2009; Mwesigye *et al.*, 2009). It was revealed that the residents in the study area lack awareness of the environmental and health risks that are associated with poor waste management through waste dumping in unauthorized drainage system, road side, public places, and burning of waste in public places. The inhabitants demand information and action from government and agencies responsible for waste management. One cannot emphasize health and environmental benefits on clean environment. Therefore, government should promote waste management practice through public awareness programs continuously and without hesitation. More dumps should be established and maintenance of the already existing ones is required.

5.2 Maize Husk Waste as Animal Feed

1. Freshly Unboiled Maize (*Zea mays*) Husk: Freshly unboiled maize (*Zea mays*) husk have higher carbohydrate content (79.89% vs. 76.51%), which is a key energy source for animals, particularly in livestock and poultry feed Illeleji *et al* (2010). Carbohydrates, primarily in the form of starches and sugars, are easily digestible and provide a quick source of energy for animals. Additionally, freshly unboiled maize (*Zea mays*) husk maintain a lower moisture content, which can be beneficial for long-term storage.

2. Boiled Maize (*Zea mays*) Husk: Boiled maize (*Zea mays*) husk, on the other hand, have a slightly higher crude protein content (4.62% vs. 3.13%) and more fiber (14.65% vs. 13.87%), which could be beneficial for animals requiring a higher protein or fiber intake. This might be more suitable for specific livestock breeds or in certain feeding

programs where fiber is important for digestion and gut health. However, the loss of carbohydrates in the boiled maize (*Zea mays*) husk might reduce its overall energy content, making it less ideal as a primary energy source in feed.

The boiling process appears to slightly alter the nutritional composition of the maize (*Zea mays*) husk, with increases in moisture, crude protein, crude fiber, and ash content, while the carbohydrate content is reduced. The overall effect of boiling on the nutritional content of maize (*Zea mays*) husk is not drastic, but it does influence the distribution of certain nutrients, which may be relevant in agricultural, nutritional, and industrial contexts. For instance, boiling might be advantageous for increasing the protein or fiber concentration in certain applications, while the fresh cob might be preferred for its higher carbohydrate content.

5.3 Conclusion

Lack of awareness is the reason waste management is not properly carried out in the study area. The residents and inhabitants are at risk of health and environmental problems which are associated with poor waste management, such as dumping of waste on the roadside, drainage, and burning of waste in open places according to the studies. Thus inhabitants were not properly educated about the importance, awareness and the health risk of poor waste management. Open dumps are responsible for the blockage of drains, breeding of flies and this could lead to spread of epidemic diseases, current waste management system is not efficient in the study area.

Freshly unboiled corn cobs are better for energy-rich feed, while boiled corn cobs might be more suited for a more balanced diet requiring higher fiber and protein content.

5.4 Recommendations

Government should establish and invest in waste management centre, like market at different zones in the city centre whereby inhabitants can sell some of the reusable materials. There should be policies based on use, reuse, reduce, recovery and disposal of used materials by the government. Inhabitants should be educated on how waste can be segregated and it should be done at the point of production with good training, standard cleaning and with thorough enforcement. Waste should be collected and transported in safe containers and open dumps should be covered to protect the environment. Waste managers should work hand in hand with inhabitants to establish sanitary landfills for disposal and treatment of wastes. Waste workers should always put on protective gadgets to protect themselves whenever at field work. Possibly government should use mechanical methods to handle waste. Also the government should educate and train the general public on the danger of casual handling of wastes.

There should be large budget allocation for waste management, and government should build recycling machine and plants to convert waste to use-able materials, so it can serve as a source of employment and income to willing members of the public. It is necessary to upgrade the open dumps to semi-controlled landfills with compacted base to drastically reduce and ameliorate infiltration of leachate to underground water. Waste should always be covered to prevent disease vectors like flies from reach, and to reduce odour in the area. Dumps should be fenced against scavengers, animals and so on. Proper waste management would encourage and promote clean environment.

The commercial nerve center of Edo State in Benin City is the Oredo, LGA there need to save Oredo from further environmental pollution. Job and business opportunities should be established in rural communities to help control the influx of rural migrants into the city centre. There should be huge allocation of fund to the ministry of environment including waste management board to be able to holistically manage the environment. There should be penalty for offenders of indiscriminate disposal of waste in the public, which could increase the internal generated revenue in Oredo Local Government Area.

References

- Abdulahi, M. M. (2009). Municipal solid waste incineration bottom ash as road construction material. *AU JT*, 13(2), 121-128.
- Abila, B. and J. Kantola (2013). Municipal Solid Management Solution. *World Academic of science, Engineering and Technology*. **78**: 313 – 318.
- Adejobi O.S. and Olorunimbe, R.O. (2012). Challenges of waste management and climate change in Nigeria: Lagos State Metropolis Experience. *African Journal of Scientific Research*, **7**: 326 – 342.
- Agba, C. (2010). *Brief on 2009 budget performance*. Ministry of Environment and public utilities to the State House of Assembly.
- Agunwamba, J.C. (1998). Solid Waste in Nigeria-problems and issues. *Environmental management*. **22** (6): 849-856.
- Akinbobola, A. (2019). Assessment of rainfall variability in some selected stations in north eastern, Nigeria. *Ethiopian Journal of Environmental Studies & Management*, *12*(2), 148-157.
- Akintola, J.O. (1986). Rainfall Distribution in Nigeria:1892-1983. Impact Publishers, Nigeria Ltd, Ibadan Pp. 1-380.
- Akolkar, A.B. (2005). Status of Solid Waste Management in India, Implementation Status of Municipal Solid Waste, Management and Handling Rules 2000, Central Pollution Control Board, New Delhi.
- Allende, R. (2009). Waste history in the Gambia. M. Sc. Thesis. University of Gambia.
- Anijah-Obi, F. N. (2001). Fundamentals of environmental education and management. Calabar: Clear lines publications.
- Ayotamuno, M. J., and Gobo. F. A. (2004). Municipal solid Waste Management in port Harcourt, Nigeria, obstacles and prospects, management of Environmental quality: *An International journal* **15** (4): 389-398.
- Ayotamuwo, M.J., and Gobo. F.A. (2000). Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects, management of environmental quality: *An international journal* **15** (4): 389 - 398.
- Badeshi, M. P. S., Williwa M. (2012). Nutritional evaluation of baby corn husk - A new feed resource for livestock. *Indian Journal of Animal Sciences*. **82**: 15, PP 48 - 50.

- Banjo, A.D. Adebanibo., A.A.R and Dairo, O.S. (2011). Perception and Operational habit of the waste managers of domestic waste disposed in Ijebu Ode, South East, Nigeria. *Africa journal of Basic and Applied Science*.3 (4): 131-135.
- Basanta, M. F., F., de Escalada pla M. F., Raffo M. D., Stortz C. A., Rojas A. M. (2014). Cherry fibres isolated from harvest residue as valuable dietary fibre and functional food ingredients. *J. Food Eng.* 126: 149 - 155.
- Breeze, R. (2012). "Municipal solid waste management in dares salaam, draft baseline analysis", The World Bank Washington, DC. Toronto- Canada.
- Buclet, N & Olivier, G. (2000). „Municipal Solid Waste Management in Europe: A Comparison of National Regimes“ in Nicholas Buclet, and Olivier Goddard (ed). *Municipal Solid Waste Management in Europe: A Comparative Case Study in Building Regimes“*, Kluwer Academic Publishers, Netherlands, 203 - 224.
- Cointreau, L & Sandra, J. (1983). „Environmental Management of Urban Solid Waste in Developing Countries: A project guide; Urban Development Technical 66 Paper Number 5, The World Bank, Washington D.C, USA.
- Cointreau-levine, S. (1994). Private sector participation in municipal solid waste management service in developing countries. Vol. 1. The formal sector-UDDP/UNCHS/ The World Bank-Urban Management Programme. Pp 52.
- Cunnigham, P. M., Cunnigham, M. A. & Saigo, B. (eds) (2005). *Environment science: A global concern*. New York: McGraw-Hill companies Inc.
- Cunningham, W.P (2006). *Principle of Environmental Science: Inquiry and Application*, McGraw Hill.
- Daskalopoulos E., Badr O., Probert S.D. (1999). Economic and Environmental Evaluations of Waste Treatment and Disposal Technologies for Municipal Solid Waste. *Applied Ecology* 58, pp.209-255.
- Deweese, D. N. (1998). „Comment on Palmer, Sigman and Walls: The Cost of Reducing Municipal Solid Waste“, Working Paper; University of Toronto.
- Donevska, K., Jovanovski M., Efremov A. and Papić J. (2006). Impact Assessment of Solid Waste Landfill in the Municipality of Center Zupa, Faculty of Civil Engineering, Skopje, Republic of Macedonia Pp 8.
- Enger, E. D & Smith B. P. (2000). *Environmental science: A study of interrelationships*. New York: McGraw-Hill.

Eucuch M., Bedigian D., Roiseux O., Besbes O., Blecker Ch., Attia. (2011). Dietary fibre and fibre - rich by - products of food processing: characterization, technological functionality and commercial applications: a review. *Food Chem.* 124: 411 - 421.

European Environment Agency (2011). Waste opportunities - Past and future climate benefits from better municipal waste management in Europe. Available: <http://www.eea.europa.eu/publications/waste-opportunities-84-past-and>, Downloaded 23.02.2012.

Fabiyi, E. F., and Hamidu, B. M. (2011). Adoption of improved technologies in soyabean processing and utilization in Tafawa Balewa local government area of Bauchi state, Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*, 11(1), 4527-4537.

Fagbemigun T. K., Fagbemi O. D., Otitoju O., Mgbachiuzor E., Igwe C. C. (2014). Pulp and Paper - making potential of maize husk. *Int. J. Agric. Sci.* 4 (4): 209 - 213. (Google scholar).

FAO. (2010) Climate-Smart Agriculture Policies, Practices and Financing for Food Security, Adaptation and Mitigation. <http://www.fao.org/docrep/013/i1881e/i1881e00.pdf>

FAO. (2017). *The Future of Food and Agriculture: Trends and Challenges*; FAO: Rome, Italy. ISBN 9789251095515. [Google Scholar]

FAO. FAOSTAT statistical database. Rome: 2015. Available from: URL: faostat.fao.org.

Folorunso, R. and Awosika, L. (2001). Flood mitigation in Lagos Nigeria through the wise management of solid waste: the case of Ikoyi and Victoria Islands. *Managing Conflicts Over Resources and Values. Results of Workshop on 'Wise practices for coastal conflict prevention and resolution'*, maputo, Mozambique, 19-23 November 2001.

Gibson, L. and Benson, G. (2002). "Origin, History, and uses of maize (*Zea mays*)," Iowa State University, <http://www.agron.iastate.edu/courses/agron212/readin>.

Holmes, J.R. Ed, (1984). *Managing Solid Waste in Developing Countries*. John Wiley.

- Ileleji, K. E., Garcia, A. A., Kingsly, A. R., & Clementson, C. L. (2010). Comparison of standard moisture loss-on-drying methods for the determination of moisture content of corn distillers dried grains with soluble. *Journal of AOAC International*, 93(3), 825-832.
- Ishengoma, A. (2000). Solid Waste Management in Promoting Environmentally Sustainable Urban Development in Dar es Salaam City. Work from Solid Waste. Women Paid as Managers Paper presented at the International Conference on Environmental and Social Perspectives for Sustainable Development in Africa, Arusha, Tanzania.
- Isu, B. A. (2005). The Pains of Waste. A Paper Presented at the workshop Organized by Committee on vital Environmental Resources for Teachers/Students, Eghosa Anglican Grammar School, Benin City, Pp. 1-6.
- John M. P., Thomas S. (2008). Biofibres and bio-composites. Carbohydrate polymer. Internatinal Foundation For Science, Annual Report. 71: PP 343 - 364.
- Kalu C., Modugun W. W. and Ubochi I. (2009). Evaluation of Solid Waste Management Policy in Benin Metropolis, Edo State, Nigeria. *African Scientist* Vol. 10 (1): 1-7.
- Kassim, S., & Ali, M. (2006). Solid waste collection by Private Sector: Households' Perspective - Findings from a study in Dar es Salaam city, Tanzania. *Habitat International*, 30, 769-780.
- Kjellen, M. (2001). Health and environment. Stockholm: Swedish International Development Cooperation Agency. Available at: <http://www.sida.se/.../pdf/20012-health-andenvironment-issue-paper.pdf>, Downloaded 12.03.2012.
- Kohajdova, Z., Karovicova J., Jurasova M. (2012). Influence of carrot pomace powder on the rheological characteristics of wheat flour dough and on wheat rolls quality. *Acta Sci. Polon. Techn. Alimen.* 11: 381 - 387.
- Lawal, M. B., Aniah, E. J., Uche, S. C., Animashaun, I. A. & Anijah-Obi-Idem (2010). Education for sustainable development. Lagos: Macmillan Nigeria Publishers Limited.
- Ludwig, C., Hellway, S. and C. Stucki. (2003). *Municipal Solid Waste Management; Strategies and Technologies for Sustainable Solution*. Berlin Heidberg: Springer-verlag.
- McMichael, A.J. (2000). The Urban Environmental and Health in a World of Increasing Globalization: Issues for Developing Countries. *Bulletin of The World Health Organization*, 78 (9).

- Miller, G.T. (1994). *Living in the Environment*; Belmont, California – Wadsworth Publishing Company: 78-83.
- Momoh, J. J. and Oladebeye, D. H. (2010). Quality Assessment of Awareness, Attitude and Willingness of People to Participate in Household Solid Waste Recycling Programme in Ado-Ekiti, Nigeria. *Journal of Applied Sciences in Environmental Sanitation*. **5** (1): 93-105.
- Mwesigye, P., Mbogoma J., Nyakango, J., Idan, A. I., Kapindula, D., Hassan, S., and Berkel, V. R. (2009). Integrated Assessment of present status of Environmentally sound management of waste in Africa: *Africa review report on waste management main report*, United Nations Economic and Social Council, United Nations Industrial Development Organization, Economic Commission for Africa, Sixth Session of the Committee on food Security and Sustainable Development (CFSSD -6)/ Regional Implementation Meeting (RIM) for CSD-18 Addis Ababa, Ethiopia. 27-30 October 2009.
- Nabegu, A. B. (2010). An Analysis of Municipal Solid Waste in Kano Metropolis, Nigeria. *Journal of Human Ecology*. **31** (2): 111-119.
- National Population commission (2006). National population and housing census of the Federal Republic of Nigeria.
- Nwaka, I. G. (2005). The Urban informal sector in Nigeria: Towards economic development, environmental health and social harming, *Global Urban Development Magazine* 1, issue 1, pp. 1-24.
- Odocha, J. N. K. (1994). "Green revolution and management in a depressed economy. In S. N. Uchegbu, 1998. Environmental management and protection. Enugu: Precision Printers and Publishers.
- Ogbeibu, A.E. (2014). Biostatistics: A Practical Approach to Research and Data Handling. 2nd Edition. Mindex Publishing Company, Benin City, Nigeria. Pp. 1-215.
- Ogboi, K. C., & Okosun, A. E. (2003). The role of scavengers in urban solid waste management in Nigeria. *Environmental Studies and Research Journal*, 2, 85-92.
- Ogu, V.I (2000). Private sector participation and municipal solid waste management in Benin City, Nigeria. *Environment and Urbanization* **12** (2), 103-117.
- Ogweleka, T. C. (2009). Municipal Solid Waste Characteristics and Management in Nigeria, Iran. *J. Environ. Health. Sci. Eng.*, **6** (3): 173-180.

- Ogwueleka, T. C. (2003). Analysis of urban solid waste in Nsukka, Nigeria. *Journal of Solid Waste Technology and Management*, **29**(4): 239-246.
- Omole, F.K. and M.K. Alakinde (2013). Managing the Unwanted Materials: The agony of Solid Waste Management in Ibadan Metropolis, Nigeria. *International Journal of Education and Research* **1**(4): 1-2.
- Onwughara I. N. Nnorom I. C. and Kanno O. C. (2010). Issue of Roadside Disposal Habit of Municipal Solid Waste, Environmental Impacts and Implementation of Sound Management Practices in Developing Country – Nigeria. *International Journal of Environmental Science and Development*. **1** (5): 409-418.
- Oyelola, O.T., Babatunde, A.I., and Odunlade, A. K. (2009). Health implications of solid waste disposal: case study of Olusosun dumpsite, Lagos, Nigeria. *International Journal of pure and Applied Sciences*. 3(2).
- Oyemiyi, B.A. (2011). Waste Management in Contemporary Nigeria. The Abuja Example. *International journal of politics and Good Governance*. **2** (2). 2-11.
- Remigios. M. V. (2010). An overview of the management practices at solid waste disposal site in African cities and towns. *Journal of Sustainable Development in Africa*. **12**(7): 233-239.
- Seadon, J. K. (2006). Integrated waste management–Looking beyond the solid waste horizon. *Waste management*, 26(12), 1327-1336.
- Seo, S., Aramaki, T., Hwang, Y. and Hanaki, K. (2004). Environmental impact of solid waste treatment methods in Korea. *Journal of Environmental Engineering*. **130**(1): 81-89.
- Sharma, B.K. (2010). *Environmental Chemistry*. GOEL Publishing House, Meerut. Pp w 1-w8.
- Tchobanoglous, G, Thesien, H and Vigil, S. (1993). Integrated solid waste management: Engineering principle and management issue. International Ed. McGraw- Hill Book Co. Singapore, Pp 12-43.
- Thomas, R., Nkosi, B.D., Umesiobi, D., Meeske, R., Kanengoni, A.T., Langa, T. (2010). Evaluation of potato hash silage from two bacterial inoculants and their effects on the growth performance of grower pigs. *South African Journal of Animal Science*. 40(4): 88-90.
- Uchegbu, S. N. (1998). Environmental management and protection. Enugu: Precision Printers and Publishers.

- Uchendu, V. C., Anijah-Obi-Idem, F. H., Jaja, S. O., Obi, F. B. & Inyang-Abia, M. E. (2010). Planning and process in environmental education. Lagos: Macmillan Nigeria Publishers Limited.
- Umunna, N.M. (2009). Solid waste generation and disposal in a Nigeria city: an empirical analysis in Onisha Metropolis. *Journal of Environmental Management and Safety*, 2(1): 181-191.
- UNCHS (1988). *Refuse collection vehicles for developing countries* HS/138/88E, UNCHS, Nairobi, Kenya.
- United Nations Environment Programme (1996). *Geo 2000: Global environmental outlook 2000*. New York: Earthscan Publications.
- Wilson, B. R., Pearson, A. M., and Shorland, F. B. (1976). Effect of total lipids and phospholipids on warmed-over flavor in red and white muscle from several species as measured by thiobarbituric acid analysis. *Journal of Agricultural and Food Chemistry*, 24(1), 7-11.
- Woodwell, G. M. (1970). Effects of Pollution on the Structure and Physiology of Ecosystems: Changes in natural ecosystems caused by many different types of disturbances are similar and predictable. *Science*, 168(3930), 429-433.
- World Bank, (2002). Data by Country. Website <http://WWW.Worldbank.Org/data/Country data.html> (Retrieved June 11, 2003).
- World Bank, (2003). *Thailand Environmental Monitor*. A joint Publication of the Pollution Control Department. The Bank US Asia Environmental Partnership.

1. Less than one year (12 months) [] 2. 1-2 years [] 3. 3-4 years [] 4. 5-9 years []
 5. 10-19 years [] 6. 20 years or more []
7. What is your highest educational level?
 1. Never Schooled [] 2. Primary [] 3. Middle school []
 4. High school [] 5. University graduate [] 6. Vocational training []
 7. Other.....
8. What is your major occupation?
 1. Farming [] 2. Business [] 3. Civil servant []
 4. Other.....

Solid Waste Management

“Solid Waste” means *left-over arising from human animal or plant activities that are normally discarded as useless*”

9. Have you ever heard about solid waste management?

1. Yes [] 2. No []

If yes, in what way? (One or more answers)

1. Over radio [] 2. Over TV [] 3. In public meeting []
 4. In school [] 5. On poster []
 6. Other.....

10. Have you ever been educated on proper waste disposal by the government? 1. Yes []
 2. No []

11. What type of solid waste comes out from the household? (One or more answers)

1. Paper and carton [] 2. Plastic (bags/bottles) [] 3. Food waste [] 4. tins/cans []
 5. Fiber bags [] 6. Glass [] 7. Other:

12. In what type of container do you collect waste? (One or more answers)

1. Carton [] 2. Waste Basket [] 3. Old bucket [] 4. Plastic bag []
 5. Tin/can [] 6. Other:

13. How often is the waste container emptied?

1. Once a day [] 2. Once in two days [] 3. Once in three days [] 4. Once a week []
 5. Other:

14. Where do you usually put away collected wastes?

1. In a public bin [] 2. In the itinerant waste van [] 3. By the valley lake side/river []
 4. By the road or street side [] 5. On an open space [] 6. In a hole in own compound []
 7. Other.....

15. Are there any public waste bins near your house?

1. Yes [] 2. No []

If yes, how long does it take you to get there?

1. 5-10min [] 2. 11-15min [] 3. 16-20min [] 4. 21-25min []

5. Other:

16. If there are public bins, how often are the nearest public bins emptied?

1. Once a week [] 2. Twice a week [] 3. Thrice a week []

4. Everyday [] 5. Don't know []

6. Other

17. How can you describe the state of the public bin near your house? (One or more answers)

1. Rusting/rotting [] 2. In a good state [] 3. Adequate size []

4. Not in a good condition [] 5. Inadequate [] 6. Don't know []

7. Other:

18. Do you think waste disposal method is a problem in your neighborhood? 1. Yes [] 2. No []

19. What problems do you think exist in your area as for waste management?

a.

b.

c.

d.

e.

20. How do you evaluate the state of solid waste collection in your house area?

1. Good [] 2. Fair [] 3. Not good [] 4. Don't have []

21. Do you know if there is a waste management center in Oredo LGA?

1. Yes [] 2. No []

22. Are you satisfied with the waste management processes in Oredo LGA waste management center?

1. Yes [] 2. No []

23. Have you ever heard about the importance of recycling? 1. Yes [] 2. No []

24. If yes, do you agree to waste recycling? 1. Yes [] 2. No [] 3. Not sure []

25. If a recycling programme was set up, would you be willing to separate materials into separate bags for collection purposes?

1. Yes [] 2. No [] 3. Don't know []

26. Please explain why the waste management is important to you?.....

.....

27. What do you suggest Oredo LGA should do to resolve solid waste problem?

.....

.....

Environment Impact

“Environment” means: *The living and non-living surroundings, natural or man-made, which makes life on earth possible.*

28. Do you know about environmental impact of solid waste? 1. Yes [] 2. No []
29. Do you ever notice waste on the road and public places? 1. Yes [] 2. No []
30. Do you ever notice waste in water recourses, such as the rivers, lakes, sea, etc....? 1. Yes [] 2. No []
31. Do you ever notice burning waste in public area? 1. Yes [] 2. No []
32. Have you ever heard of health problems due to solid waste? 1. Yes [] 2. No []
33. Do you notice the presence of the following in and around public waste bin or dumpsite? (*One or more answers*)
1. Dark flowing water [] 2. Odour [] 3. Mosquitoes and cockroach [] 4. Fire []
5. Domestic animals [] 6. Rats/Reptiles [] 7. Scavengers [] 8.
- Others.....

Please tell how concerned you are about these issues in the table.

	Concerned	Not Concerned
34. How concerned are you about environmental pollution in the city?	[]	[]
35. How concerned are you about the health impact of waste?	[]	[]
36. How concerned are you about Sustainable Development?	[]	[]

37. Would you personally say that solid waste is a major issue currently affecting the LGA natural environment?
1. Yes [] 2. No []
38. Do you think there is enough available information about the environmental impacts of solid waste in your area?
1. Yes [] 2. No []
39. Do you think most environmental issues in the LGA could be minimized if solid waste is managed properly?
- Yes [] 2. No []
40. Do you agree that the new developmental process has impact on solid waste management in your area?
1. Yes [] 2. No []
41. Overall, how would you rate the quality of the environment in the LGA now when compared to years ago?
1. Much better [] 2. A little better [] 3. The same [] 4. A little worse [] 5. Much worse []

Sustainable Development

Sustainable Development means; *“promoting development at a rate and such a way as to ensure that quality of the environment and the supply of the resource is maintain and, wherever practicable, enhanced to meet the needs of the present generation without compromising future generation ‘need’”.*

42. Have you heard of “Sustainable development”? 1. Yes [] 2. No []

43. Are you aware of sustainable development in your area? 1. Yes [] 2. No []

44. Can you explain the importance of sustainable development as/like you think?

.....

45. Do you think solid waste management has impact on sustainable development? 1. Yes []
2. No []

46. Do you agree that solid waste management centre should be developed in the city for sustainable development?

1. Yes [] 2. No []

47. Do you believe there should be environmental conservation for sustainable development? 1. Yes []
2. No []

What is the reason for your answer?

48. Do you agree that every single person has a responsibility to contribute to sustainable development in the city?

1. Yes [] 2. No []

49. Finally, please tell me are you satisfied with the Oredo LGA waste management processes? 1. Yes []
2. No []

Thank you for your participation!!!