IMPACT OF URBAN POULTRY FARMS ACTIVITIES ON KUJE SUBURBIA ENVIRONMENT, ABUJA, NIGERIA

The 21st Century has been characterised with an unprecedented rate of urbanisation. Presently, about 50% of global population are resident in cities, and this is projected to rise to 70% in year 2050. This rapid rate of urbanisation is associated with unemployment and urban food security challenges. To address the food security challenges in cities, urban residents have embraced the practice of urban agriculture – a practice which involves the production of animals and crops in urban and peri-urban areas. The study examined the impacts of urban poultry farm activities on Kuje Suburbia environment, Abuja. The aim is to assess the major pollutants emitted from the poultry farms, and their environmental impacts on surface water, soil and air quality with a view to proffering planning and management solution towards sustainable and healthy environment in Abuja. The study adopts a triangulation approach involving the practice of using multiple sources of data to analysing data to enhance the credibility of a research study. The study employed geospatial, experimental and quantitative approaches to address the research questions for this study. The study employed two stage sampling technique, random sampling technique of poultry farms based on scale of operation and purposive sampling nearest to the residents within 500 meters away. Six (6) selected poultry farms operating in Kuje were sample and test for possible pollutant of the test analysis on the samples - surface water, borehole water and well water. A laboratory sample test and measurement was carried out to determine the physiochemical parameters of water (surface, borehole and well water), soil and air quality on poultry farms activities in Kuje Suburbia. The analysis results revealed the presence of some concentration of heavy metals above the WHO/NESREA recommended standard. Findings reveals high concentration of heavy metals in water, soil and air quality by activities of the poultry farm in Chibiri community. Furthermore, the Lead present in the soil sampled at the four locations were above the permissible limits. A high concentration of Lead in the body may result in severe and permanent brain damage, convulsion and death. The air quality analysis in the study area revealed the presence of some pollutants which is caused by the poultry activities, this implies that the poultry activities in the study area have adverse effect on residents and this could result into serious health challenges. Data were collected with the use of structured questionnaire. A total of 360 respondents were administered questionnaire for the study. The perceived knowledge of the residents on impacts of poultry farms activities revealed a mean rank score of 4.60. Also, it was revealed that, 61.1% of the respondents complained about the locations of the poultry farms pollutes their environment with bad odour and 28.3% complaint that the poultry farms attracts rats/flies into the environment. In conclusion, the study has shown that the poultry farms activities have adverse impacts on their environment in Kuje sub-urbia. The study recommends among others the need for appropriate distance between poultry farms and residences to be determined and enforced by regulatory authority. This will help to mitigate the effects of environmental pollution /health hazards on the residents.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The 21st Century has been characterised with an unprecedented rate of urbanisation. Presently, about 50% of global population are resident in cities, and this is projected to rise to 70% in year 2050 (Ngome and Mulinya, 2018). Similarly, 50% of Nigeria's population is classified as urban and this has been projected to rise to 57% in 2025 (Bloch *et al*., 2015). This rapid rate of urbanisation is associated with unemployment and urban food security challenges. To address the food security challenges in cities, urban residents have embraced the practice of urban agriculture a practice which involves the production of animals and crops in urban and peri-urban areas (Tornaghi, 2014).

Mechlem (2004) noted that food is a fundamental right that has been recognised in the General Statement of Human Rights. Sassi *et al.* (2018) also noted that, the human rights approach to food security recognises the obligation of the government to ensure that they feed their citizens with adequate and nutritious food. However, it has been observed that governments all over the world have not been able to meet up with this obligation (Hossain *et al.*, 2015).

As an effort to combat urban food insecurity and unemployment, residents both in the urban and peri-urban areas in the Global South are engaged in urban farming (Tacoli, 2017). Food and Agricultural Organisation (FAO) (2010), reported that 22.8% of the population of sub-Saharan Africa is hungry. In Nigeria Idrissa *et al*. (2008) observed that about 66% of the country's population are food poor. Urban agriculture includes backyard farming and its widely recognised in addressing urban nutritional deficiencies, unemployment, increasing urban poverty, mostly bought about by rapid rural-urban migration, structural adjustment policy, economic transition, and improved agricultural policies (Taylor and Lovell, 2012; Taiwo and Falohun, 2016). Among others in Nigeria, the poultry industry is the most developed animal industries and urban agriculture. Generally, the growing of poultry industry all started as an effect of the high demand of energy and protein, rapid income rate and short period of incubation (that is 21 days) which have more advantages of poultry above other livestock animals (Mokwunye, 2000).

Poultry farming is one of the major urban agricultural practices in Nigeria. It is a vital approach toward providing urban residents with the required protein intake in form of eggs and meat. To buttress the foregoing FAO (2007) observed that in the worldwide poultry production has made some tremendous changes in order to meet the increasing demand for economical and safe distribution of meat and egg. This increase in demand has been accompanied by organizational changes within the sector, which is characterised by the development and growth in commercial and trade farming establishments as well as the increase of poultry processes (FAO, 2007). Following the observation of Sassi *et al.* (2018), poultry farming is capable of addressing the four core scopes of food safety, vis-a-vis food availability, food access, food consumption and food permanency. However, poultry farming has been associated with a plethora of health and environmental impacts (Foeken, 2006).

Large scale poultry farming has been linked to the outbreak of epidemics such as respiratory diseases like tuberculosis, Severe Acute Respiratory Syndrome (SARS) and Avian Influenza (H5N1) as well as Salmonella (FAO, 2010; Hu *et al*., 2017; Foeken, 2006; Oduwaiye *et al*., 2017). Greger and Koneswaran (2010) also reported the link between poultry farming in residential areas and the emergence of new disease pathogens.

In the year 2006, before the outbreak of Highly Pathogenic Avian Influenza (HPAI) in Nigeria, the poultry population was estimated to be around 150 million of which the large majority was observed to be local chickens and the minority was observed to be exotic breeds. Yerima and Emeka-Okolie, (2008) whose faecal discharges engenders severe respiratory disorders. These negative health impacts of poultry farming are developed and transmitted during the poultry production process; and the transmission of the diseases is facilitated when the poultry farms are located in or close to residential areas (Hu *et al.*, 2017; Oduwaiye *et al.*, 2017).

Poultry farming is also associated with environmental pollution, especially air pollution (Van de-Steeq *et al*., 2009; Reeve *et al*., 2013; Pohl *et al.*, 2017). The air pollution arising from poultry farms is a major cause of farmers-resident's conflicts (Ritz *et al.,* 2005). Urban agriculture has been identified as a potent and sustainable approach towards ensuring urban food security (Veenhuizen, 2006) and also attaining the green cities target equally (FAO, 2010; Pearson and Pearson, 2010). Urban agriculture, including poultry production, is therefore, a very vital tool in attaining the spatial planning ideals of biophilic/nature-sensitive urban planning and design (Koont, 2011). However, in realisation of the likelihood of negative environmental effects arising from urban poultry production, Van de-Steeq *et al.* (2009) suggested the need to evaluate the environmental effects of poultry production in urban areas and how these impacts are linked to health/hazard outcomes and value of life of the residents.

Also, in the wake of the current Corona Virus pandemic (COVID-19), people are lawfully worried about the places where they live are affecting their health and wellbeing. To mitigate public health impact, social (physical) distancing as a measure to interrupt transmission among residents was suggested by Velavan and Meyer (2020), to avoid seemingly perilous density of metropolis. The (COVID-19) origin and transmission developed from rapid globalization and urban growth, which aided transmission from animal to humans, from one person to another person, from one city to the other, and from a country to another country (Ng *et al*., 2020). Thus, pose a renew critiques of densely concentrated living, the connectivity of people and places that necessitate the re-assessment of spatial implication of livestock farms in and around cities and urban areas. It is in line with the foregoing arguments that this study, therefore, examines the impacts of poultry farms activities on Kuje suburbia environment Abuja, Nigeria.

1.2 Statement of the Research Problem

The effects of poultry farms have been studied from various perspectives. Delgado *et al.* (2016) in their research indicated that meat consumption is growing globally, and this has led to the increasing of livestock litters that poses environmental hazards. Kalhor *et al.* (2016) specifically focused their studies on pollutants from poultry production, the emissions released from poultry houses are significantly methane, Ammonia (NH3) and Sulphur Dioxide (SO_2). Li *et al*. (2018) posited that the administered antibiotic to the livestock is within the range of 30% - 90% and are defecated non-metabolic through fertilizer in the environment. Xie *et al*. (2018) also confirmed that these antibiotics pollutes the environment through human activities and increases the economic advantage of antibiotic resilient bacteria pollution of antibiotics in the environment by progressively reforming the resilient in the environment.

The research of (Alabi *et al*., 2014) found out that chicken droppings generally contaminate poultry houses with their litters and poses environmental hazards during the period of dumping the litter. The inappropriate chicken waste disposal leads to environmental threats such as unpleasant odour from the poultry houses, soil pollution, breeding of flies and water pollution. Locally and globally the atmospheric pollution is as a result of livestock methods which are seen as the major source of trace gases in the environment (Appuhamy *et al*., 2016). Global total emissions of livestock production and their by-products were recorded for 18% (IPCC, 2014). Other studies focused on the amount and rate of chicken waste generation and nutrient contents of poultry waste production which are affected by some elements (Adedayo, 2012; Adeoye *et al.*, 2014).

The above-mentioned studies, emphasis is primarily on waste generation, environmental pollution from poultry production on human health. There is little research on issues related to the assessment of major pollutants released from poultry farms and the impacts on surface water, soil, and air quality on residents of the host farms. This is a major gap that this study seeks to address.

1.3 Research Questions

i. What form of the poultry production farms exist in Kuje Suburbia?
ii. What are the major pollutants released associated with poultry farms that have effect on surface water, soil, and air quality?
iii. What are the resident's perception of the poultry farms in Kuje Suburbia?
iv. Is there any level of complaints on environmental pollution caused by poultry farms?

1.4 Aim and Objectives of the Study

The aim of the study is to assess the impact of poultry farm pollutants on Kuje Urban environment with a view to proffering planning and management solution towards sustainable and heathy environment in Kuje Suburbia, Through the following objectives.

1.4.2 The Objectives of the study work is:

i. Identify poultry farms and production capacity in Kuje Suburbia.
ii. Assess the impacts of the poultry farms activities on water, soil and air quality in Kuje Suburbia.
iii. Examine the resident perception of the environmental impacts of poultry farms in Kuje Suburbia.
iv. Examine the nature and level of complaints on environmental pollution caused by poultry farms.

1.5 Significance of the Study

Environmental pollution and health effects of poultry farms have been reviewed by different studies, but little research has been attempted to systematically explain the major poultry farms pollution emitted, their environmental effects, and the likely human health hazards from exposures to them. Also, farms smells are exhibited around the built-up area in Kuje Suburbia. This prompts the idea of this studies in order to fill in the gap. More so, a comprehensive review of environmental and health effects of poultry farming will illustrates the importance of this study. Similarly, major impacts of poultry farms will be identified on the residents and human health. This study, therefore, will prove indispensable to urban policy makers, planners, health, and environmental organizations on environmental impacts of poultry farms. Finally, it will establish a lasting environmental sustainability through the assistance of Government and other interested parties in the society in Kuje Suburbia.

1.6 Scope of the Study

The scope of the research work covers the assessment of poultry farms and production capacity, the impacts of the poultry farms activities on water, soil and air quality, the resident perception of the environmental impacts of poultry farms and the nature and level of complaints on environmental pollution caused by poultry farms in Kuje Suburbia (Chukuku, Kiyi and Chibiri).

1.7 Study Area

1.7.1 Location of the study area

The land area of Kuje Area Council covers about 1,800 square kilometres with percentage of 22.5% of the FCT. The population is recorded to be over 270,000 people which comprises of the Gbagyi. Gade, Bassa, Fulani and other languages that moved from different parts of Nigeria and the worldwide (Ojigi *et al*., 2012). The Kuje Area Council is bounded on the North and East of Abuja Municipal Area Council (AMAC) West of Gwagwalada Area Council and the South of Abaji Area Council. The average rainfall of the Area Council is 1200 millimetres and rain from the month of April to the month of October, whereas the dry period begins in the late October to March.

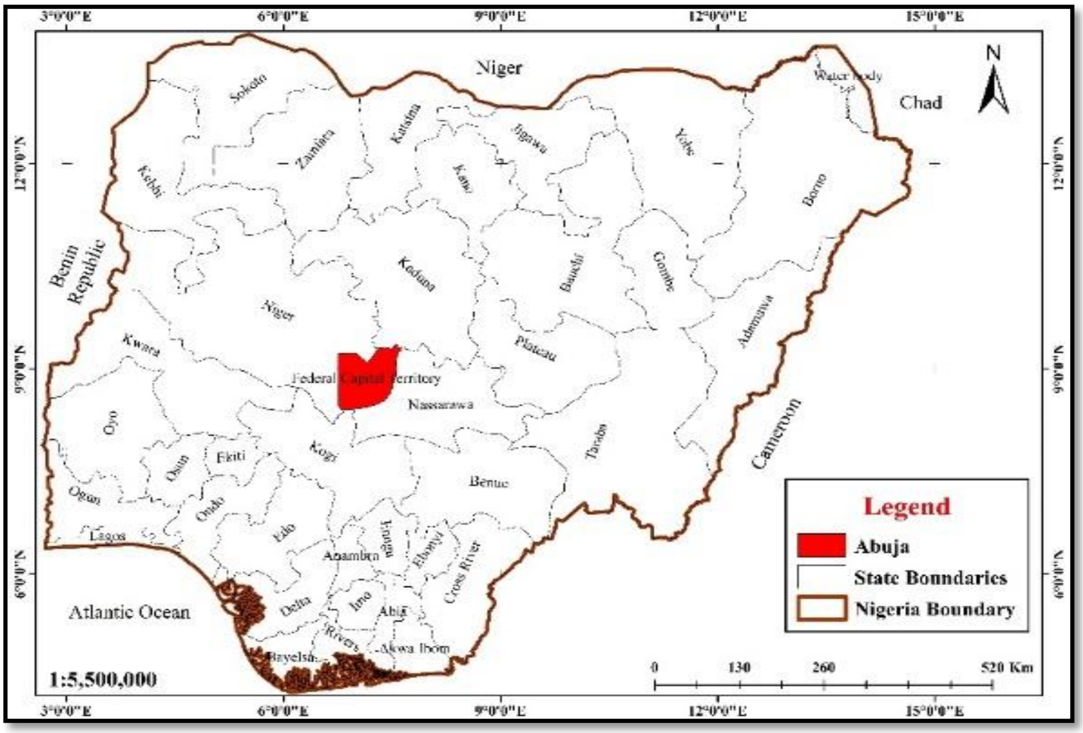

Figure 1.1: Location of FCT- Abuja in Nigeria

Source: Digitised by the Author

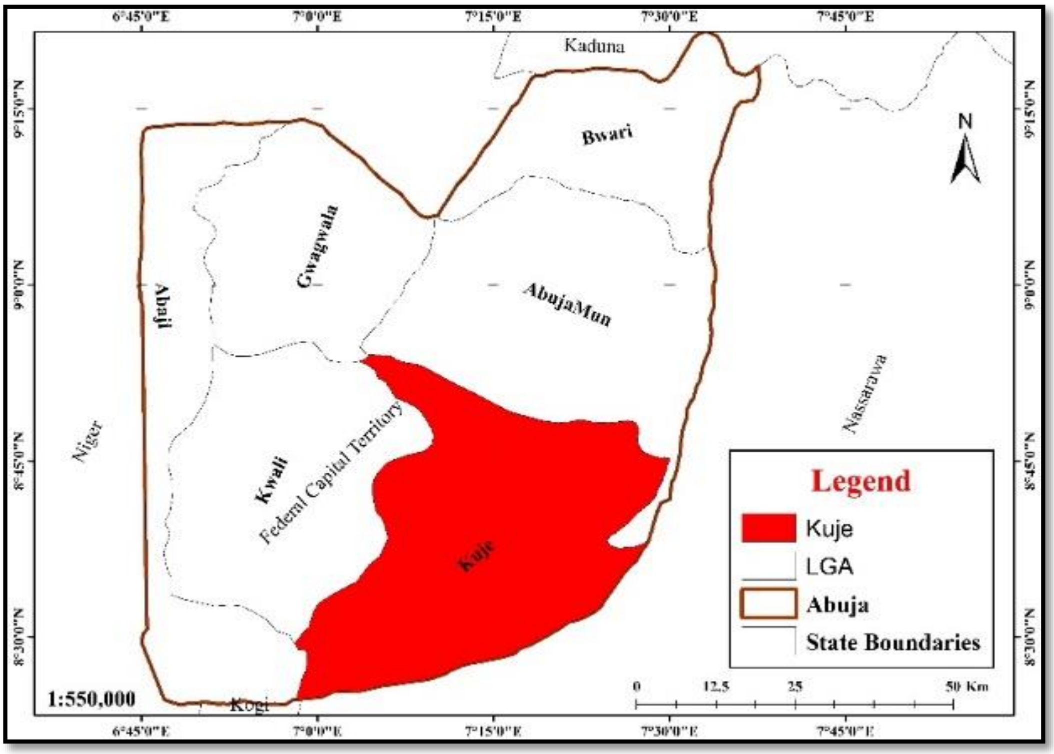

Figure 1.2: Location of Kuje Area Council in Abuja
Source: Digitised by the Author

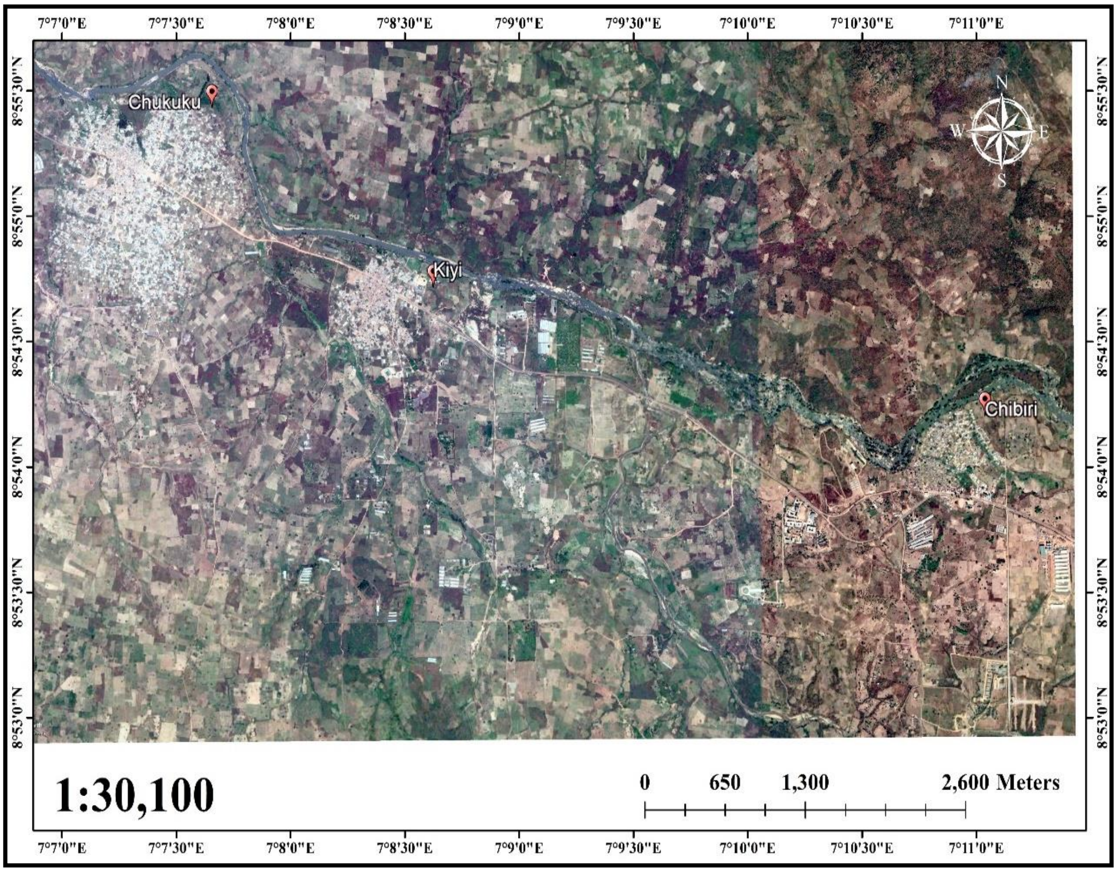

Figure 1.3: Satellite Imagery of Kuje Suburbia
Source: Google Earth Satellite Imagery, (2020)

1.7.2 Climate and temperature

The temperature of Kuje Area Council ranges between 21°C to 26.7° annually and with a total annual rainfall of about 1.650milimetere (mm). The month of July, August and September are accounted for 60% for the annual rainfall. Heavy breeze, lightning and heavy rainfall are regarded as a frequent occurrence. (Ojigi *et al.*, 2012).

1.7.3 Topography and relief

The Kuje Area council is predominantly underlain by some geographical features such as Precambrian magmatities, gneiss, granites, and schists of the crystalline basement complex. The area is good for groundwork construction excepts for the western boundary of the region which has extrusive schist belt outcrops. Quaternary alluvial deposits are found in the Usman River network providing a nearby origin that is fit for construction purposes (Ojigi *et al.*, 2012).

1.7.4 Vegetation and soil

Soil in this Area Council is of a high degree of comprises of different soil such as sandy soil, loamy soil, silt, clay soil, gravel. Hence, the area is prone to erosion when observed along the footpaths and road. Nonetheless, vegetative cover in the area has significantly reduced the phenomena.

1.7.5 Socio-economic activities

The major commercial activities in the rural parts of Kuje Area Council is agriculture (farming) and the types of crops grown are mainly yam, maize, rice, cassava, guinea corn and millet. The large area abundance of grazing land in the area council has enable livestock production. The Area Council is accessible by land and telecommunications.

Also, it accessible from the capital city within thirty (30) minutes and from the Airport within twenty (20) minutes (Ojigi *et al.*, 2012).

It is also known that Kuje Area Council has the establishments of significant banks, institution and headquarters and ministries all located within the boundaries of the Area Council. Equally, investors are investing on livestock production since the Area Council is blessed with a vast grazing land. The Area council is also known to have the most fertile land in Nigeria because of the large area and industrial farming it flourishes well. The Area Council is blessed with a large arable land and rich soil. It also falls within the highest crop producing belt. The Area Council gives room for exchange of goods and services due to the proposed railway terminals in Abuja (Ojigi *et al.*, 2012).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical framework

The adopted theories significant to this study include the urban sustainability theory, Liveability theory, and epidemiology transition theory.

2.1.1 Urban sustainability theory

The term 'sustainable development was popularised by the report of the Bruntland Commission held in 1987. In the article, sustainable development is the growth that "meets the desires of the current without the undermining the upcoming generations to meet their individual wants" (United Nation, 1987).

Cities are considered as complex adaptive socio-biophysical systems (Childers *et al.*, 2014). James *et al.* (2015) noted that cities are currently the habitat and 'zone of survival' of humanity in the 21st century. They identified the need to shift emphasis from the growth-based narrative to a more holistic consideration of cities as ecological systems whose alterations are capable of threatening human existence. Childers *et al*. (2014) observed that the urban sustainability is a result-based and solution-oriented theory that considers humans as ‘ecological stewards.

In other word, urban sustainability is concerned with the development and consumption of healthy and liveable cities (Steiner, 2014; Wolch *et al*., 2014). As James *et al*. (2015) argued, “The challenges of this planet is from the cities, nevertheless emerging an optimistic and sustainable method of urban living is the only way to achieve a sustainable life”.

The need for making cities sustainable has been recognized (Bernt and Rink, 2010; Kirkpatrick and Smith, 2011). According to Bernt and Rink (2010) current cities are characterized by a plethora of ecological crises however, maintained that sustainable cities are liveable cities. Therefore, the concept, although originating from the field of ecology, has assumed an interdisciplinary nature over the years (Childers *et al*., 2014). The extent of the adoption of the concept of urban sustainability has engendered the development of sustainability science among urban ecologists and planners (Rapport, 2007; Weinstein, 2010; Larson, 2011; Spangenberg, 2011; He *et al*., 2018).

Urban sustainability theory helps the urban planners and policymakers in developing policies, plans and programmes that are environmentally friendly and less injurious to the health of the urban residents (Register, 2006; Birch and Wachter, 2008). However, Weinstein (2010) and Chinders *et al*. (2014) reported that urban growth, industrialization and other urban production processes hinder constitute significant obstacles in the quest for sustainable cities. Interestingly, Yigitcanlar *et al*. (2015) argued that urbanization is the primary factor that places urban sustainability at the center of the sustainable development debate. They maintained that urban sustainability is central to the accomplishment of the general target of maintainable growth. Beatley (2016) observed that some production activities in urban areas constitute pollution and therefore, poses environmental health impacts to the resident of cities, thus, suggest that urban sustainability is achievable through nature-friendly urban design.

Sustainability studies are increasingly focused on the relationship between ecological health and human well-being (Musa *et al*., 2020). Urban sustainability is "the process of adapting to enabling and sustaining an essential cycle between environmental facilities and human comfort over concentrated environmental, financial and social activities in response to changes within and beyond the urban landscape". Jenks and Jones (2010) urban sustainability have several interdependent and interrelated dimensions. Three key dimensions of urban sustainability are social sustainability, economic sustainability, and environmental sustainability (United Nations Conference on Sustainable Development (UNCSD), 2001; James *et al*., 2015; Yigitcanlat *et al*., 2015). This study focuses on the ecological and human health aspect of the sustainability.

The United Nations Sustainable Development Goals were changed in 2015 emphases on monitoring and improving development at the international, continental, nationwide, regional, and indigenous levels. The Goal three (3) aims at achieving 'good health and wellbeing', while Goal 11 precisely aim at achieving 'sustainable cities and communities' (Klapper *et al*., 2016). Although targeting concentrated efforts towards the actualization of sustainability in cities, there is need to rethink urban design, planning and management to ensure the attainment of healthy cities (van der Sluis, 2007; Cole, 2015; Wang *et al*., 2015).

2.1.2 Liveability theory

Worldwide, both at indigenous and international basis, cities face different challenges. Approximately cities are undergoing intensified urban heat (Corburn, 2009). Similarly, Baker, (2012) posited that cities are experiencing climate change caused by natural disasters, whereas some are experiencing air and noise pollution as a result of industrial activities. (Pacione, 2003). Sometimes these problems could generate to or worsen community challenges, for example, lack, isolation, redevelopment, and overpopulation (Pacione, 2012). The occurrence of all these has the tendency of affecting the perceived "liveability" of cities in essence, the quality of the ecological association of the individual, as well as the surrounding environment and the availability of services to fulfil the residents wants and potentials. This impact on liveability are generally observed as negative impacts however not all cities are affected to an equivalent degree, due to their environmental positions or socioeconomic circumstances (Gasper, 2011).

Conceptually, in the studies of Van Kamp *et al.* (2003) and Pacione, (1990) liveability is generalized in urban life to three major components which reflects the important basics of the individual association with the environment which includes Firstly, the element is the surrounding and natural environment along with the infrastructure, described as "urbanized method". The second element characterizes what this environment can provide for the people as "urbanized roles", also reflects how the individuals make use of the environment in the essence of its functionality. The third element is the quality of the previous two elements itself, which is defined as "urbanized livability", that is how well the environment can content the residents' wants and potentials.

Livability is regarded as an urban structure which contributes either to the physical, social, psychological comfort or individual development of all its populations. It is about pleasant and desired urban spaces that offer and reflect cultural and sacred development. The Significant principles that give substance to this theme includes; equity, self-esteem, availability, kindness, input and empowerment (Pacione, 2003).

A functional town is seen to be an urban area where mutual areas are the hearts of community life and the accents of the whole public. A functional town must be urbanized, or reinstated, as a constant system since the essential spaces to the extra reserved settlements where the everyday routes and bicycle-route are different and do not bind composed, respectively has its own route in all the places of community quality and of the social life (Salzano, 1997).

2.1.3 Epidemiology transition theory.

Epidemiology is seen as the study of circulation and defining the well-being and disease in anthropological inhabitants in order to aid well-being facilities to be planned wisely, disease investigation to be carried out, and protective and control programmes to be executed and assessed. (WHO, 2007). Epidemiology is one of community health's bases, with an emphasis on the determinants of diseases and the causal issues that determine this distribution. Similarly, it aims to know the figure of a population that are effected by different illnesses and complaints, in what way and why these statistics variation, and how these forms affect the population at large to signify and know occurrences of illness and death. (Krickeberg *et al*., 2012). The epidemiology studies in the context of this studies enables to address the issues of various pollutants emitted from intensive poultry production and their impact on human and animal population.

The epidemiologic transition theory, subtle to the provisions of populace academics who have stressed the demographic, biological, sociological, financial and psychological significances of intermediate procedures with the goal to form the instruments of communication that describe the designs, factors and costs of well-being and illness changes in a diversity of community settings" (Omran, 1971).

2.2 Conceptual Framework

2.2.1 Concept of environment

Conceptually, environment is seen as a composite of many changes, surrounding man as well as the living organisms (Wiedemann *et al*., 2017). Atmosphere encompasses (water, air and terrestrial) and the inter-relationships that exist between water, air, and land and lives of human and other existing beings such as floras and bacteria (Kumarasamy *et al*., 2004). According to Williams *et al.* (2016) environment comprises of an intimate complete system created by physical, biological, organic, social and traditional elements, which are interwoven independently and equally in many ways. This interrelationship creates an ambient and quality environment for the continuity of life (Wang *et al*., 2015). The aforementioned elements and dimensions of the environment affect human existence either positively or negatively (Wiedemann *et al*., 2017). Poultry production in urban areas has been associated with considerable amount of air and groundwater pollution (Williams *et al*., 2016).

2.2.2 Concept of environmental impact assessment

Environmental Impact Assessment (EIA) was reported by the International Association for Impact Assessment (IAIA, 1999, 2013) as "the method of recognizing, forecasting, assessing and to mitigate the biological, practical, community, and other important impacts of proposed project/growth prior to main choices being taken and obligations made (IAIA, 1999, 2013). The benefits of EIA were identified by (Kenneth *et al.*, 2010), which includes: Provides both developer and the competent authorities the opportunity to choose a viable project having been breasted with the complete understanding of their effect on the environment.

Adequately equipped significant experts to make the required decision whether to allow the project to proceed or not. It provides project developers and decision makers the ability to forecast and evaluate the possible negative effects of the proposed plan on the well-being of man and the natural environment, by expanding on the likely alternatives recommended through and also assist in recognizing substitutes through endorsing the implementation of suitable changes that integrate financial, social and environmental concern; aid to increase the integrity and also shows a good company descriptions for an organization as an ecologically accountable organization to the general public with government organizations and employee.

Also, it provides the bank and other financial institution that extend credit to their client the insert to a project that will affect the environment or not and could be able to decide which to invest in or otherwise. Allows the assessing of the environmental impacts of a project on a common measure by financial budgets and benefits. Permit public contribution and other subdivisions in environmental organization.

Defend output and volume of natural systems and the environmental procedure which preserve their purpose. Also, in the research of Gerber *et al*. (2005) the major likely environmental effects of poultry farming especially on soil and underground water properties include the following:Eutrophication of ground water as a result of the contribution of carbon-based elements and nutrients also by poultry effluent production leaching from storing and control management services which affects water system and drinking water quality. Leakage of nitrate, and likely pathogen transmissions to surface water affecting the drinking water quality. Growth of nutrients and some other components in soil due to constant use of surplus amounts of compost. Effects of effluence on nutrient-sensitive environments due to biodiversity fatalities.

The effluence of Nitrogen is being regarded as posing a danger to the soil and water quality. These dangers are due to high levels of nitrates, which can be leaked to the underground water table or to stream water affecting eutrophication. Nitrogen, when in nitrate method is very movable in soil result and which could effortlessly be leaked underneath the rootling area and into underground water. The fast growing of exhaustive poultry farming in different part of the world has made area and local phosphorus disparities (Gerber *et al*., 2005). The use of composts has caused other phosphorus to be applied than crops need, and improved potential for phosphorus dead in shallow runoff. This condition is increased through compost management being nitrogen based. When manure is applied to meet the nitrogen wants of most crops, a considerable accumulation of phosphorus happens in the soil (Burton and Turner, 2003; Alabi *et al*., 2014).

2.2.3 Concept of urban agriculture

One of the visible impacts of urbanisation is seen in the area of food security (Redwood, 2008). Self-sufficiency is a major determinant of urban sustainability (Pearson and Pearson, 2010). Urban agriculture is a vital tool towards combating urban food insecurity on the one hand and making cities self-sufficient on the other (Neeteson-van-Nieuwenhoven *et al.*, 2013). Urban agriculture has been defined as the practice of agricultural activities – rearing of animals and cultivation of crops in urban areas (FAO, 2010; Game and Primus, 2015).

Urban agriculture has gained considerable attention in the last few decades (Despommier, 2013; Orsini *et al*., 2013; Tornaghi, 2014; Game and Primus (2015). Although urban farming is considered as a global practice (de Bon *et al*., 2010) the practice of agricultural activities in urban areas is more noticeable in cities of developing countries (FAO, 2010). It has been observed that poultry production is one of the major agricultural practices in urban areas (de Bon *et al.,* 2010; Orsini *et al*., 2013).

2.3 Poultry Farming

Poultry are farm birds raised for either consumption as chicken meat, egg, or for fertile egg production (Akanni and Benson, 2014; Alabi, *et al*., 2014). These birds are kept either using extensive method, semi-intensive method, or intensive managing systems (Paraso *et al*., 2010). Any method that is accepted, poultry raising helps as a good lesser profession that increases the revenue of small-scale farm relations and country families in most industrialized countries (Pardo *et al*., 2012; Anang, *et al*., 2013).

Poultry farming establish a fascinating and different group of animals, which can be combined into some farming systems in the world for the mutual advantage of animals and the humans involved (Pelletier, 2008). Their capability to change several types of feed, such as residuals from farming activities, families, and food processing productions, into animal crops and protein bases is more effective than many other animals class (Skunca, *et al*., 2018). They contribute to food safety, protein supply, and peoples' living makes them valued animals on a globally (Anon, 2018; Skunca *et al*., 2018)**.**

2.3.1 Poultry production and wastes management impact

The rapid growth of Poultry farming in Nigeria cities in the modern days has resulted to increase in waste accumulation most significantly of wastes and composts by the following ecological effects (Adeoye *et al.,* 2014; Onu and Ekine, 2015). The poultry litters are by-products of feed substances or manures, dead birds, hatchery litters, wastes (bedding materials such as timber shreds, sawdust, chaff, rice hulls) (Charles, 2008; Moreki and Keaikitse, 2013; Onu and Ekine 2015).

Poultry litters comprises some vital nutrients for vegetal development with micronutrients and trace components (Chan *et al.,* 2008). Also, it comprises pathogens, hormones, antibiotics, and heavy metals (Kalu *et al*., 2016). These ammonium salts, greenhouse gases and residuals of bacterial synthesis can pose enormous ecological problems which includes contaminating the stream water and underground water if not well managed (Idowu and Otuniaya, 2002; FAO, 2006; Ayodeji *et al.,* 2011; Adeoye *et al.,* 2014). Poultry wastes are not only rich and essential in terms of plant nutrient it is similarly used in the production of poultry feedstuffs and raw material substrates for bio-gas production (Idowu and Otuniaya, 2002). The small-scale farming, worms in the poultry litters are fed to fish to decrease feed cost and increase yield gain in fish (Idowu and Otuniaya, 2002; Ayodeji *et al*., 2011). However, this system must be properly managed in order to remove the possible hazard that can caused the lives of aquatic animals **(**Moreki and Chiripasi 2011; Adeoye *et al.*, 2014).

Equally, in the studies of Idowu and Otuniaya (2002), posited that about 10% of poultry wastes are recycled in livestock feeds in Nigeria regardless of the various significance and usages. In the research of Mijinyawa and Dlamini, (2006); Ayodeji *et al.,* (2011); Moreki and Keaikitse, (2013) and Adeoye *et al.* (2014). They proved that the practice of poultry waste management follows the same pattern across some African Countries. For example, studies have shown that Studies have shown that discarding waste close to wasteland or flushing waste into ditch or rivers are the utmost type of waste managing practices though very few farmers practice it in Nigeria and Botswanan cities (Ayodeji *et al.,* 2011; Moreki and Keaikitse, 2013). It is practice in order to save cost but result into polluting air, water, and soil (Idowu and Otuniaya, 2002).

The Environmental Policy of Integrated Waste Management (IWM) of Ghana is transformed and gradually becoming a recognised practice (Cofie and Drechsel, 2005; Adedayo, 2012). This practice always remains the utmost environmentally pleasant approach to waste management (McAllister, 2015). Through Integrated Waste Management (IWM), community contributions, independent administrations and management organizations are encouraged, and ecological nationality is produced amongst the public associates (McAllister, 2015).

Livestock faeces on the ground surface or sub-surface can pollute the surface water and nearby water bodies with poisonous components (including lead, nitrite, zinc, and copper) and pathogens through discharge and corrosion but an appropriate checked is practiced. Equally, animal faeces are indecisively influential to pollute water, air and soil if the agronomic approval of the receiving crop is fewer than the nutrient credits (Cofie and Drechsel, 2005; Charles, 2008). Also, the choice of dumping method differs from each farmer as well as areas (Charles, 2008). Thus, concerns associated with the environment, social health, possible revenue gain and the value of life for the poultry farmers as well as the individuals living distant and nearby from urban poultry production operations make waste management a serious concern for the long-term development and sustainability of poultry production.

2.3.2 Poultry production in Nigeria

In Nigeria poultry production comprises of local (backyard) and exotic breeds which are raised underneath the permitted choice conditions and the concentrated systems (Anosike, 2007). The local poultry establishes approximately 84 percent of entire poultry production, whereas the unusual donates around 14 percent to the entire poultry production in Nigeria (Akanni and Benson, 2014; Alabi *et al.*, 2014). According to studies, greater percentage of livestock farming in Nigeria is still at the sustenance level and managed by courtyard poultry farmers. Nonetheless, the studies of (Ekunwe *et al*. 2006) noted that poultry production has presumed a significant part with vast abilities for fast financial development in Nigeria. The National Bureau of Statistics (NBS) (2010) revealed that in Nigeria, poultry farming has observed countless increase in the number of chickens and also in the poultry management.

Okoli *et al*. (2007) noted that poultry production in Nigeria is basically characterized into extensive (wide), intensive (half) and intensive production systems. The intensive system can be said to involve the large raising of livestock breeds birds for commercial production and of high performance. The essential achievement of commercial poultry production in the tropics has made the profitable very attractive in most developed countries.

Oluyemi and Roberts (2000) revealed that the commercial production of poultry involves the rise of large components in city centres has changed poultry manure or faeces from a benefit to problematic of a widespread irritation in an era where there is much concern with effluence of the environment. Furthermore, Oluyemi and Roberts (2000) also noted that a layer is estimated to produce approximately 63kg to 70 kg manure of each bird annually and that each week, 1,000 layers in cages produce one (1) ton of manure whereas on deep litter, they are likely to produce thirty (30) tons of excreta content mixed with waste of variable fibre and dampness matters.

2.4 Environmental and Health Implications of Poultry Farming

Piha *et al*. (2007) and Broto and Bulkeley (2013) indicated that rapid growth of urban agriculture is related with greenhouse gases emissions (GHGs) and Ammonia (NH3) releases and climate change which contributes to the pollution of the atmosphere both in the local and global areas. Similarly, IPCC (2014), Appuhamy *et al*. (2016) and van der Weele *et al*. (2019) posited that poultry production systems are the main sources of trace airs which contributes to the pollution of the atmosphere both local and global. The greenhouse gas releases of poultry production and its by-products are accounted for eighteen (18) percent of global entire emissions, suspended solids, nutrients, metals and pharmaceutical composites (Pimentel *et al*., 2005; Rodić, *et al*., 2011; Sabiha *et al*., 2016). Application of Livestock manure has the consequence of nutrients and antibiotics which leach from soils into underground and stream waters, taking an overwhelming impact on quality of water, supporting the development of algae, hastening eutrophication, and encouraging the spread of antibiotic resilient bacteria (Hooda *et al*., 2000; Martinez, 2009; Girard *et al.*, 2014; Sabiha *et al*., 2016; Almeida *et al.*, 2017).

International Finance Corporation (IFC) (2007), Adrizal *et al*. (2008), Acosta-Alba *et al*. (2012), and Schader, *et al*. (2012) indicated that waste generated in poultry production includes waste food, animal dump or excreta, carcasses, residues and mud from on-site waste effluence management facilities, several types of packing for feedstuff and insecticides, used airing waste, unused or spoilt treatments and used washing resources. Alauddin and Quiggin (2008) and Acosta-Alba *et al*. (2012) further noted that air release from poultry production include hydrogen sulphide, odour and ammonia which are caused mainly due to denitrification of manure and can be emitted directly into the atmosphere.

Čermak *et al*. (2010) reported that rice hulls or litter spread over the ground in poultry houses become polluted with droppings of the chickens. Disposing this polluted rice hull or litter poses some environmental threat as improper disposal led to breading of flies and unpleasant odour and water pollution (Basset-Mens and van der Werf, 2005; Bastianoni *et al*., 2010; Boggia, *et al*., 2010; Belflower *et al*., 2012). It was observed that water drops over the litter on the flows while chicken drink water from the troughs and when the litter becomes wet, it gives rise to an unpleasant odour which can be a source of annoyance for the workers and nearby communities (Brouček, 2014; Brouček and Čermak, 2015).

Sharply (1998), Capper *et al*. (2009), Calvet *et al*. (2011), Castellini *et al*. (2012), and Busola, *et al*. (2017) reported that the concentration of poultry production and growth in operational size leads to some consequences on the environment. To avoid this, International Finance Corporation (2007), Chai *et al*. (2010); Cesari *et al*. (2017); and Clark and Tilman (2017) recommended that poultry litters should be managed and disposed in respects to the rules and regulation to avoid harmful situation and achieve favourable balance and safety environment.

2.4.1 Impact on the resident and local environment

Local conflicts and site dilapidation are characteristics of resident adverse services in the environments of poultry farms (Coufal, *et al*., 2006; Costa *et al*., 2012; Corkery *et al*., 2013). The cause of water and soil with other contents such as nutrient, heavy metals are due to poor management of manure and this occurs wherever manure is kept (De Vries and De Boer, 2010; Da Alvarenga *et al*., 2012; Da Silva *et al*., 2014). Manure can also be used on cropland belonging to the animal farm or marketed (Gerber *et al*., 2005). The process of recycling manure from poultry farms further creates severe environmental and health impacts (FAO, 2006; Djekic *et al*., 2014; Dalólio *et al*., 2015; Ewemoje *et al*., 2017).

Poultry production causes odour and attracts flies, mosquito, rodents and pests which create local irritations and carry diseases. (Alali *et al*., 2010 and Grandl *et al*., 2012). Odour releases, affects a large quantity of subsidising mixtures such as (Ammonia NH3, Volatile Organic Compounds VOCs, and Hydrogen Sulphide H2S), from poultry farms adversely impact the indiviviual life existing in the area (Gillman, 2006; Dunkley *et al*., 2013; González-García, 2014; Espino and Bellotindos, 2020).

Flies are regarded as one of the concerns for inhabitants living close to poultry farms (Alabi *et al*., 2010; Grandl *et al*., 2012; Dunkley *et al*., 2013). Study conducted showed that dwellings that were found very close to poultry farms (within half a mile) had eighty-three (83) periods of the normal figure of hovers and parasites that could spread illnesses, which include ;(malaria, dysentery, typhoid, and cholera (Hobbs *et al*., 2004; Green *et al*., 2009; Harper *et al*., 2010; Hossen *et al*., 2015). Therefore, the presence of poultry farms in residential areas of the city is linked to the incidence of water pollution (Jones *et al*., 2013; Kalhor *et al*., 2016; Hu *et al*., 2017; Işık and Kırkpınar, 2020). This results from the insecticides that was used to control pests (such as pests and virus vectors) and predators which is the source of pollution when they enter underground water and stream water (Kalhor *et al.*, 2016; Hu *et al.*, 2017; Lavers *et al*., 2017).

2.4.2 Effects on the global environment

Environmental effect of poultry farming is not continuously limited to particular parts; they likewise comprise effects of a worldwide measurement (Katajajuuri *et al*., 2008; Knižatova *et al*., 2010a; Knižatova *et al*., 2010b, 2010c). Two (2) concerns are of significance in this, first, the manufacture of essence feedstuff and greenhouse gas production associated to vitality use in animal production methods and in the transportation of managed products (Fisher *et al.*, 2005; Li and Xin, 2010; Leinonen *et al*., 2012; Leinonen and Kyriazakis, 2016; Leinonen *et al*., 2014, 2016).

Inappropriate dumping of poultry carcasses contributes to quality of water harms particularly in regions disposed to flooding or wherever there is a low water table (Li, *et* *al*., 2011; Liu *et al*., 2011). Approaches for the dumping of poultry carcasses such as; burial, incineration, composting and rendering (Meda *et al*., 2011; Lyngbye, 2013; Maheshwari, 2013; Meier *et al*., 2015; López-Andres *et al*., 2018).

In the situation of current Highly Pathogenic Avian Influenza (HPAI) epidemics, the dumping of great figures of diseased birds has obtainable original and difficult challenges related to environmental pollution (Steinfeld *et al*., 2006a; Liu *et al*., 2011). Great volumes of carcasses generate to extreme quantities of leach and other toxins, increasing the likely pollution of the environment (Gerber *et al.*, 2005; Mihina *et al*., 2010; Moore *et al*., 2011; Mostafa and Buescher, 2011). Buried birds undergo a decomposition process (Liu *et al*., 2011). In this method, nutrients, pathogens and other constituents of the carcass are emitted into the environment (Tabler, 2006; Suffian *et al*., 2018). As these components enter the nearby soil, they can remain fragmented, different, vanished to the air, or else restrained so that they pose no environmental hazard (Knižatova *et al*., 2010b). Burton and Turner (2003) posited that there is a likelihood that some elements could ultimately pollute soil, groundwater, and stream water. Another associated problem is the disposal of manure from poultry production that comprise diseased chickens (Tallentire *et al*., 2017).

Tuomisto *et al*. (2012) and Tallentire *et al*. (2017) assessed the effect of dead-bird removal on underground water quality. Tuomisto *et al.* (2012) examined underground water quality around six dumping pits and revealed that manufacturers used open-bottomed pits for their everyday death dumping. These pits, they reported, are not severely the similar as burial pits, however there are some comparisons.

2.5 Environmental Concerns at the Level of Production Handling Unit

Basically, this unit offers outlines of environmental issues at the local level, rising from poultry farms. In this level, effects are typically openly perceived by farmers, neighbours, inhabitants and policy-makers.

2.5.1 Animal production

During production, local disorders (for instance pollution, mosquitoes, flies, and rodent's) also land dilapidation are characteristic resident bad facilities in the environments of poultry production. Contamination of water and soil with nutrients, pathogens and heavy metals are usually affected by poor compost-management and arises anywhere compost is kept (Lyngbye, 2013; Maheshwari, 2013; Meier *et al*., 2015). Pollution of soil and water are associated to poultry waste though, usually not a concern at the production place, as poultry compost is merely directly discharged into the environment in special situations. (Rutherford *et al.*, 2003).

2.5.2 Local disorders

Poultry farms are majorly the source of pollution and draw mosquito, hovers, rodents and including vermin that generate resident irritations and carry diseases. Releases such as odour from poultry houses negatively impact the life of residences living around the area. Pollution related to poultry processes originates from new and decaying waste produces such as compost, carcasses, feathers and litters (Kolominskas *et al*., 2002 and Ferket *et al*., 2002). Farm pollution is majorly released from poultry houses, and compost and storing amenities. Smell from animal feeding processes is not affected by only complex, nonetheless is rather the effect of a great quantity of contributing mixtures such as Ammonia (NH3), Volatile Organic Compounds (VOCs), and Hydrogen Sulphide (H2S)

(Institute for European Environmental Policy, 2005). Some of the compost-based mixtures which produce odour, the utmost usually reported is Ammonia (NH_3). Ammonia (NH_3) gas has a harsh and strong odour and can act as a nuisance when existing in high concentrations (Schiffman, 1998).

Odour is a local concern, which is hardly measureable; the effect significantly depends on an individual perception of inhabitants adjacent the farms (Rodić *et al*., 2011). Therefore, it is hard to assess the determined distance over which odour gas journeys; but, odour concerns are usually determined within 0.5km from the farm (Tallentire *et al*., 2017). The emission of odours characteristically depends on the regularity of poultry house cleaning, on the temperature and wetness of the manure, on the kind of manure stowage, and on-air travels (Lyngbye, 2013; Maheshwari, 2013; Meier *et al*., 2015). Thus, this aim is usually higher in ducks' farms than in poultry farms (Institute for European Environmental Policy (IEEP), 2005).

2.5.3 Land use and landscape

The tendency to more production units, and their local concentration, certainly is likely to negatively impact neighbouring land application and the form of the site (Piha *et al*., 2007). Pelletier (2008) observed that substantial industrialised poultry fittings can generate a negative visual effect. Effect on land use in extremely determined parts is shown by battle with growth requirements and around areas with country travel (Rodić *et al*., 2011; Tuomisto *et al*., 2012).

2.5.4 Poultry carcass removal

Inappropriate removal of poultry remains can result to quality water harms especially in regions disposed to to flooding or somewhere there is a low water table (Suffian *et al*., 2018). Alabi *et al*. (2010) and Adeyemo and Onikoyi (2012) observed that the approaches for the removal of poultry carcasses such as burial, incineration, composting and rendering. In the case of modern Highly Pathogenic Avian Influenza (HPAI) epidemics, the removal of large quantities of diseased birds has presented new and difficult harms related with environmental pollution (Akanni and Benson, 2014 and Alabi *et al*., 2014). Large volumes of carcasses can create extreme amounts of leach and other contaminants, growing the possible ecological pollution.

Buried birds experience a decay development; and during this development, nutrients, pathogens and other constituents of the carcass are released into the environment (Akanni and Benson, 2014). As these elements enter the nearby soil, they can be broken down, changed, lost to the air, or then immobilized so that they will not be able pose any environmental danger (Alabi *et al*., 2010; Adeyemo and Onikoyi, 2012; Akanni and Benson, 2014; Alabi *et al*., 2014). However, there is a likelihood that some components might ultimately contaminate the soil, underground and stream water (Freedman and Fleming, 2003). Another associated problem is the elimination of compost from houses that contain diseased birds.

2.5.5 Slaughter house

The utmost important concern of the environment results from slaughterhouse processes is the release of effluent into the environment (Akanni and Benson, 2014). Similar to other food-processing activities, the need for cleanliness and quality regulator in meat processes effects in high water practice and subsequently high levels of wastewater generation (IEEP, 2005). Poultry handling activities necessitate great volumes of good water for method cleaning and cooling. Typical water usage in poultry slaughterhouses varies within 6 - 30 cubic metres per tonne of produce (Alabi *et al*., 2014). Large amounts of water are used in poultry production for evisceration washing and cleaning (European Union (EU), 2003).

Effluents process created through these activities characteristically has high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) due to the concentrations of organic constituents which includes; (faeces, meat, fat and blood). However, wastewater procedure can comprise high levels of nitrogen, phosphorus, and deposits of substances such as chlorine used to wash and disinfects, including numerous pathogens as well as Salmonella and Campylobacter (World Bank, 2007). Poultry consequences and waste might contain up to hundred (100) diverse species of bacteria, as well as pathogens, in polluted feathers, feet and abdominal substances (Arvanitoyannis and Ladas, 2007). Characteristic values for wastewater created from poultry handling are 6.8 kg Biochemical Oxygen Demand (BOD) per ton live weight killed (LWK) and 3.5 kg suspended solids per ton of LWK (de Haan *et al*., 1997).

Poultry slaughterhouses release large volumes of waste into the environment, contaminating land and surface waters as well as posing a severe human-health risk. The discharge of environmental biological mixtures can cause a strong decrease of the quantity of Dissolved Oxygen (DO) in surface waters, which in turn can lead to reduced levels of activity or even death of aquatic life. Macronutrients (nitrogen and phosphorus) may cause eutrophication of the affected water bodies. Excessive algae growth and subsequent dying off and mineralization of these algae can lead to the death of aquatic life because of oxygen reduction (de Haan *et al*., 1997).

2.6 Poultry Compost

Poultry compost comprises some significant quantities of nutrients as well as nitrogen, phosphorus, and also excreted constituents which include hormones, antibiotics, pathogens and heavy metals which are found through feed (Steinfeld *et al*., 2006b). Leakage and overflow of these elements has the latent to effect in polluting of stream water and underground water resources.

2.6.1 Nutrients

Livestock raised in exhaustive production structures consume a large quantity of protein and other nitrogen comprising elements in their diets. The change of dietary nitrogen to animal produces is moderately unproductive; 50 – 80 percent of the nitrogen is defecated (Arogo *et al*., 2001). Nitrogen is defecated both in biological and mineral composites. Nitrogen releases from compost and it involves four main methods which include; Nitrogen (N2), Ammonia (NH3), Nitrate Oxide (N2O) and Nitrite (NO3-).

2.6.2 Heavy metals

Compost comprises large volumes of potentially poisonous chemicals such as Lead (Pb), Arsenic (Ar), Copper and Zinc (Bolan *et al*., 2004). When all of these components are in surplus, can become toxic to plants, have negative impacts on beings that feed on these floras, and also go into water systems through surface overspill and leakage (Akanni and Benson, 2014).

2.7 Environmental Impact of Poultry Pollutant Emissions

Contaminants emitted into the environments in variety from poultry and livestock productions with the air releases and the removal of large quantities of animal waste. These contaminants not only have negative impact on the air quality, stream water, soil, and underground water, but also poses threats to community well-being, as indicated on Figure 2.2 below (Centner and Patel, 2010). The ecological and human well-being significances can become possibly important in the regions not far from poultry farms if the problem is not tackled with the fast growth of industrialised livestock farming (Cole *et al*., 2000; Donham *et al*., 2006; Reeve *et al*., 2013; and Pohl *et al*., 2017).

Also, Greger and Koneswaran (2010) posited that hydrogen sulphide, which is the procedures from anaerobic decay of poultry waste, is another vaporous consequence of major concern. Distribution of the animal waste to countries, mainly in the cases of where the application is more, could also release the bacterial causes and produces confined in the livestock waste, including the gaseous produces into the air (Greger and Koneswaran, 2010).

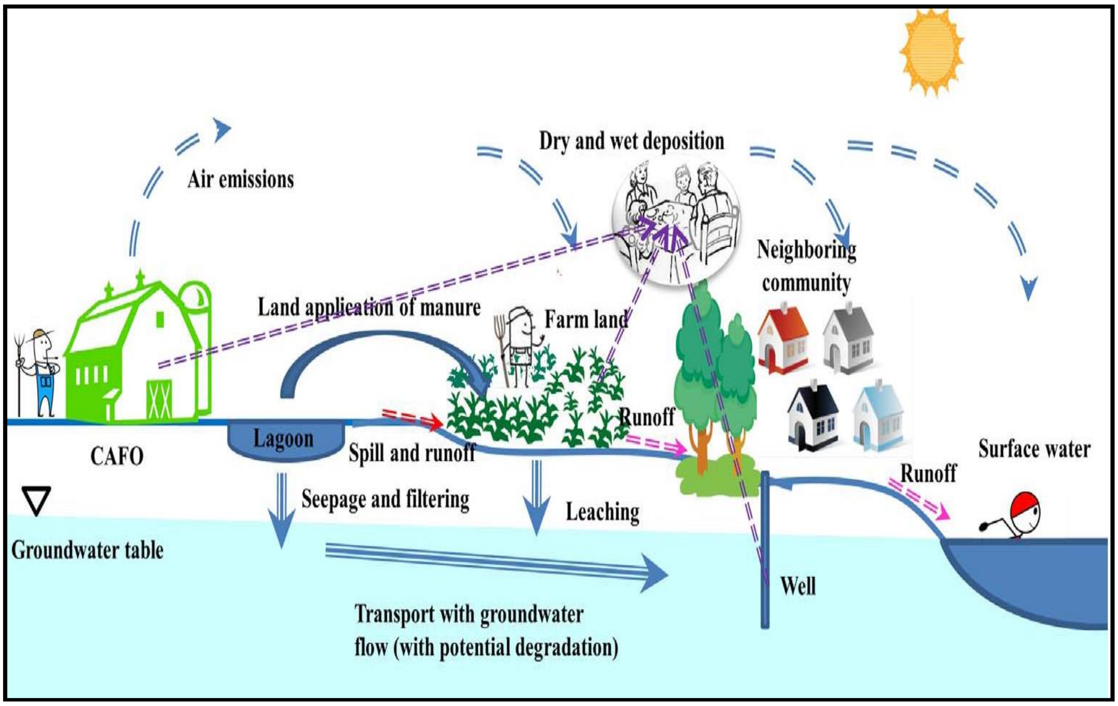

Figure 2.1: Transportation of Contaminants Emitted from Poultry Production and the Pathways these Contaminants Could Pose Hazard to Mental Health in Rural Areas
Source: Centner and Patel *et al*., (2010)

2.7.1 Types of environmental impacts of poultry farms.

2.7.1.1 Impact on soil and water

Delgado *et al*. (2016) revealed that "livestock uprising" has happened, indicating a development in meat feeding globally, that has basically led to an upsurge of waste by poultry production which poses hazards into the environment. Furthermore, (Knapp 2015;

Wilkinson and Garnsworthy 2017) explained that (for instance, nutrients as well as metals and protein content in foods are in excess in respect to the definite necessity of animals, and only a minor amount of them is fascinated by the animal.

Studies conducted by Almeida *et al*., 2017; Girard *et al*., 2014; Hooda *et al*., 2000; and Martinez, 2009 indicated that livestock wastes have, in common, a high content of organic matter, suspended solids, nutrients, metals and pharmaceutical composites. As the significance of instable land use of livestock compost, nutrients and antibiotics might leakage from soils into underground and surface waters, having a disturbing result on quality of water, supporting the development of algae, hastening eutrophication, and encouraging the spreading of antibiotic resilient microorganisms.

2.7.1.2 Effect on air

Similarly, poultry farming has effect on air through the productions of Ammonia (NH3) and Green House Gases (GHG) characterized by methane (CH4), Nitrous oxide (N2O) and Carbon Dioxide (CO2), rising alongside from poultry houses, backyards, compost stowage and management, and land distribution (Baldini *et al*., 2018; Hou *et al*., 2016). Furthermore, (Erisman *et al*., 2008) in their research opined that ammonia (NH3) productions have an adverse effect on human well-being and the environment, as they are the main accountable gas in eutrophication and acidification developments, and in particularly in substance creation.

2.7.1.3 Effect on crops

Application of animal's dung on land gives minerals and microelements benefits to crop development, but also components that could collect in their matters go inside the food chain. Substantial chemicals tend to be engrossed in partial quantities, though antibiotic absorption still wants further study (Pan and Chu, 2017). Crop uptake of tetracycline tends to be easier than sulphonamides and macrolides since they are comparatively hydrophilic at pH range of soils (Pan and Chu, 2017).

2.8 Approach/Techniques/Models of Measuring Environmental Pollutions (Soil, Water, and Air)

2.8.1 Approach/techniques/models of measuring air pollution flux chambers

Misselbrook *et al*. (2000) in their studies revealed four (4) methods for determining Ammonia (NH3) pollutants from poultry houses and compost stowage which include (leading a form stability, by means of a shortest dimension method for Ammonia (NH3) absorption and aeriation rate, using distant detecting through micrometeorology and ambient sample, and using shortest dimensions of absorptions along with a tracer gas to control airflow rates). Furthermore, (Misselbrook *et al*., 2000) posited that the initial three (3) methods are best appropriate to region source dimensions. The challenge with the initial technique is the chemical changes of the composites of interest. Definitely a mass stability can be done on nitrogen in compost stowage, but finding illustrative examples is not an easy duty and defining the gaseous method of the released nitrogen entails extensive information of the chemical reactions in the stowage.

The studies of (Gates, 2000) explored on the use of a balance chamber to equate the impact of nutritional management on ammonia volatilization. They further explained that this method does not directly amount production; relatively the absorption of a gas in the headspace above a closed sample capacity that covers an area is determined. A close-fitting bottle is positioned over the producing superficial and non-stop absorption analyses are noted till quasi steady-state circumstances are attained. This absorption is the driving potential for mass flux from the emitting surface. In order to define emission rates, the apparent mass transmission resistance is essential. Since the dependence amid apparent resistance, external speed, and mass transmission resistance at the solid-gas or liquid-gas line, the technique is not directly beneficial for emission estimations without extra standardisation.

2.8.1.1 Micrometeorological method

This technique of micrometeorology is fundamentally a technique that uses mass equilibrium to compute spatially averaged productions. It is regarded as some methods that mix fluidities over large spaces, do not interrupt the sampling area, and let studies of the variations in fluxes with varying atmospheric and surface conditions (Fowler and Duyzer, 1989; Harper *et al*. 2010; Thompson and Meisinger, 2002; Zahn *et al*., 2001). The above few researchers revealed how they carried out their studies using these techniques to evaluate emissions from inlets and land use areas. The technique includes the simultaneous dimension of upright shapes of wind speed and concentration at one or more points inside the emitting area. Gas concentrations and wind speed dimensions are frequently taken at the middle of the foundation with a spherical shape to confirm that wind is always vertical to the source and that the raise over the source is continuous and equal to the range of the circle.

In the studies of Zhu *et al*. (2000**)** posited that odour was measured at seven (7) different amenities to define everyday changes. Also, air samples were collected each two (2) hours over a 12-hour period through the day. Watts (1994**)** measured odour emissions from a feedlot cage with a moveable wind tunnel for a period of five days following 64 mm of rain. The maximum emission arose around 48 hours later the last rainfall. The highest odour concentration was about 60 times greater than odours from the dry cage.

2.8.2 Approach/techniques/models of measuring water pollution

The American Public Health Association (APHA) (1989) revealed some analytical parameters that was used to determine the standard techniques of water contamination.

Water pH is measured through the use of a pH meter (Combo Hi 98130, Hanna USA), Turbidity through the use of spectrometry (Hach DR/4000, UK), and Dissolved Oxygen (DO) by the use of electrometric technique using an oxygen-detecting electrode (Model 970, Jenway, EU). Biochemical Oxygen Demand (BOD) is determined through the use of the dilution method; presence of nitrate-nitrogen (NO3-N) and phosphate is determined through the use of absorption spectrometry using the sodium salicylate technique for NO3-N, and the vanado-molybdo-phosphoric acid technique for phosphate. Furthermore, (Ademoroti, 1996) revealed that, presence of sodium and potassium are also determined using a flame photometer (Model PFP 7, Jenway, UK) later absorption with hydrochloric acid. Presence of lead, cadmium, and zinc also evaluated by using the Atomic Absorption Spectrophotometric (AAS) technique (Buck Scientific, Model 200). Total coliform is measured using the plate count.

2.8.3 Approach/techniques/models of measuring soil pollution

In accordance with ISO 17O25 (ISO, 2005), soil analysis was carried out by a recognised laboratory standard and recommended techniques for sampling, defined in ISO (ISO, 2009). The soil sample's location was taken at various soil samples from two different depths (surface layer between 0-20cm and the subsurface between 20- 40cm) respectively, in accordance with the area sampled as recommended by the ISO 10381. The machine was used to dry, grind, and sieve the samples according to ISO 11464 (ISO 1994). In order to measure the total content of metals (Arsenic (As), Iron, Nitrogen, Cadmium (Cd), Lead (Pb), Nickel (Ni), Chromium (Cr), Copper (Cu), Zinc (Zn)) and Phosphorus a portion with grain mass less than 65μm was used, since for pH, Total Nitrogen (TN), and Total Organic Carbon (TOC) a portion of less than 2mm was used.

Mass contents of Cadmium, Lead, Nickel, Arsenic, Copper, Chromium and Zinc in the soil samples were measured by legalised non-standardized techniques established by the Regional Laboratory of the Ministry of the Environment and Waters (Chepanova *et al*., 2008). The techniques and procedures used were verified through involvement in inter laboratory comparative laboratory tests reporting compatible results. Value of results was determined by study of Certified Reference Materials NIST 2709 (San Joaquin soil) and CRM 142 (light sandy soil), having a similar matrix (baseline trace element concentration) as the studied soils. Subsequent retrieval was gotten for the basics which includes: (Arsenic= 101-110%, Cadmium =97–100%, Lead= 90–101%, Nickel =93–98%, Chromium =78%, Copper= 94–99%, Zinc = (95–101%), and Phosphorus= 90–110%) respectively. Other factors such as pH, Total Nitrogen, and TOC were measured in accordance to the recommended standards methods (ISO, 2005). The content of Total Nitrogen was determined by modified Kjeldahl method according to ISO 11261 (ISO 1995). Quality control was tested by analysis of CRM NCS DC 85104 and the retrieval gotten was between 105-108% for Ntot and 90-98% for TOC, calculated again as carbon-based element.

2.9 Global and Local Standards of Assessing of Environmental Pollutions (Soil, Water, and Air)

Table 2.1: Guidelines of Accessing Water Quality

Parameters	**Guidelines**
pH	6.5 – 9.2
Temperature	30°C
Conductivity	900uSiemen
Chloride	200mg/1
Calcium	75mg/1
Chemical Oxygen Demand	80mg/1
Manganese	0.05 – 0.5mg/
Iron	0.1- 1.0mg/1
Copper	0.003mg/1
Cadmium	0.003mg/1
Lead	0.01mg/1
Mercury	0.01mg/1

Source: WHO, (2013)

Table 2.2: Standards/Guidelines of Assessing Soil Pollution

Parameters	**Guidelines**
pH	6.5 – 8.5
Conductivity	1000
Organic matter	1.5 -5.0g/kg
Organic Carbon	
Total Nitrogen	10g/kg
Nitrate	0 – 0.3g/kg
Total sulphate	200g/kg
Chloride	250g/kg
Phenolic compound	10g/kg
Arsenic	2.0g/kg
Cadmium	1.3g/kg

Source: WHO, (2013)

Table 2.3 Ambient Air Quality Standards

Pollutants	**Guidelines**
Particulate Matter	250µg/m3
Carbon monoxide	10ppm
Sulphur Dioxide (SO2)	0.1ppm
Nitrogen oxides	0.04 – 0.06ppm
Non- methane Hydrocarbons	160µgm3
Photochemical oxidant	0.06ppm

Source: WHO, (2013)

2.9.1 Effects of parameters sample on human life and livestock

2.9.1.1 pH

pH generally indicates the intensity of the acidic or alkalinity condition of a sample on which the permissible limits by WHO is between 6.5 and 9.2. (Marcus *et al*. 2012) revealed that a good drinking water most at 7.0 is as neutral as possible. Excessiveness in either alkalinity or acidity is harmful to health. Alkalinity is the quantifiable capacity of a sample to defuse a solid acid to an intended pH. Alkalinity is important in the treatment of natural and wastewater.

2.9.1.2 Temperature

According to Oyem *et al.* (2014) temperature values are constant with hot belt, it can be measured as being ambient qualified to topographical area. High temperature adversely impacts quality of water by improving the development of microorganisms which can upsurge taste, odour, colour and erosion difficulties It is quite significant in portable drinking water and waste water. High temperature favour multiplication of bacteria than normal temperature and must not exceed WHO acceptable limits of 30^{oC}.

2.9.1.3 Conductivity

The concentration of ions in the water causes electrical conductivity of water. This conductive ion come from liquefied salts and mineral constituents for example alkalis, chloride, sulfides and carbonate compounds (Environmental, 2014). High conductivity is an indicator of pollution resulting from large number of dissolved substance and may induce unfavorable physiological reaction in some consumers. The WHO minimum permissible limit is 900u Siemen.

2.9.1.4 Chemical oxygen demand (COD)

Oyem *et al*. (2014) revealed that the Chemical Oxygen Demand (COD) is credibility to the cleanliness of the water, suggesting however, gain very negligible carbon-based concentration, interpreting by inference to good taste, odour, and aesthetic value. Chemical Oxygen Demand (COD) is imported measured parameters for river and industrialised waste studies and control of waste management plant, falling septic systems and agrarian and city runoff, act as a food source for water borne bacteria, nonetheless must be between the WHO permissible limits of (80mg).

2.9.1.5 Copper

Naturally, Copper occurs in waters, effluence liquids and industrial waste as soluble copper, salts or as precipice copper composites on suspended solids. Trace quantity of copper are essential for normal absorption similarly its deficiency is recognized to cause nutritious anemia in offspring. Large quantity intake of copper can cause emesis which may eventually result in liver damage. Copper is often added to ponds to control aquatic plant life. Large amount has toxic effects on fish (Paul *et al.*, 2016). The content of it in water most not exceed WHO permissible limits of (0.05-0.5mg/l).

2.9.1.6 Calcium

Calcium is seen to be the fifth (5^{th}) and richest elements present in natural water between the level of zero milligrams per liters. It contributed to the rigidity properties of water and test effects frequently are reported as hardness of calcium. Calcium is good for human, animals, and plants. But high content of it ranges from 2, 5grams daily, it can result to growth of kidney stones and sclerosis of kidneys and blood vessels (Pallar *et al.,* 2020). The minimum allow of calcium content in water is (75mg/l).

2.9.1.7 Total Dissolved Solids (TDS)

Total Dissolved Solid (TDS) combine the amount of all ion elements that are lesser than 2 micro u Siemen (0.002cm). This involves all of the dissociated electrolytes that makes up salinity concentration, including other composites such as liquefied carbon-based matter in wastewater or polluted area water. TDS includes organic like hydrocarbons and urea in addition to the salt ions. Excessive TDS can produce toxic effect on human and animals. Its shows contamination of water (Oyem *et al.,* 2014). WHO permissible limits of (500mg/l).

2.9.1.8 Manganese

Manganese is considered as a lead to visual problems like taste, dour, colour, slime and low pressure. Also, they are considered as secondary contamination that has little effect on public health when concentrated in underground waters as the divalent ion due to the absence of sub surface oxygen. Surface waters might comprise combination of manganese in numerous corrosion states as solvable complexes or suspended solids. The amount of Manganese in public water supplies results to dark tints in laundry and on plumbing fixtures, tends to deposit lines water. It also has impacts on objectionable taste to beverages like coffee and tea. (Paul *et al.*, 2016). But must not exceed the WHO permissible limits of (0.05-0.5mg/l).

2.9.1.9 Dissolved Oxygen (DO)

Dissolved Oxygen (DO) is the quantity of oxygen found by determination at the period of collection. It is the level of acceptable, non-compound oxygen concentrated in water or as well as liquids. It is important parameters in evaluating water quality, because of its effect on the organism living in a body of water. Dissolved Oxygen is a vital secondary element only to water itself. Dissolved Oxygen (DO) level that is either high or too low can endanger aquatic life and have adversely impact quality of water (Environmental, 2014). It also levels in natural and effluence waters and is dependents on the physical, biological and chemical activities prevalent in the water body. Dissolved Oxygen (DO) is an important test in water contamination control activities and effluence treatment process control within the permissible limits of (0.2mg/l).

2.10 Review of Global and Local Research Findings on Poultry Farm Pollution on Soil, Water, and Air Monitoring

Environmental concerns in local production settings, regional level as well as global scales is as a result of rapid growth and increase of poultry sector. (Gerber *et al*., 2005). Discharges of effluents into the water bodies is an occurrence in most emerging nations of the world because surface water (river and stream) are regarded as no man's assets. Poultry effluents in both stream and river waters do upsurge nutrient, solid and metal loads of stream water quality, thus, resulting to algae bloom, reducing light diffusion, improved turbidity, bioaccumulation of poisonous metals and disturbance of ecology (Taiwo *et al*., 2013).

Poultry compost is the key contaminant related to poultry farm processes, which on decay decreases oxygen heights of a river and cause fish loss. Other ecological hazards and irritations related with poultry processes such as odour, dust and gases, insecticides, medicinal and pathogens (Anon *et al.,* 2018). The extreme releases of nitrogen, phosphorus, zinc and copper through poultry effluents originate from extra supplies of protein and phosphorus in livestock preparation and as well by the physiologically insufficient use of important trace components (Edwards, 1997). This may negatively impact both the water and earthly environments. Ammonia gas is seen as a nasal and respirational nuisance related to animal composts contributing to water quality challenges (Richardson, 1997). Nitrates from dung and fertilizers may be leaked into underground water and produced a number of human wellbeing challenges (Ward *et al.*, 2005).

Dennis and Cheng (2013) in their studies reported some important stages of Cadmium, Zinc and Lead in poultry composts and poultry manure-amended soil. These metals may found themselves militarised into the water environment through runoff. Furthermore, Fatoki *et al*. (2002) revealed that the presence of heavy chemicals in the water environment has extensive impacts straight to the biota and indirectly to man. Cadmium is one of the most poisonous chemicals with reported cancer-causing adverse impacts in humans (Taiwo *et al*., 2016). The fact of attack for cadmium is the kidney and liver where it adds in high concentrations, thereby leading to chronic kidney dysfunction. Also, it is poisonous to fish and other water creatures (Woodworth and Pascoe, 1982).

Bulut and Baysal (2006) in their studies posited that Lead (Pb) is potentially dangerous and poisonous to most systems of life accountable for quite a number of illnesses in persons such as chronic nervous illnesses, anaemia, brain damage, anorexia, mental deficiency, nausea and even death in human. Zinc (Zn) has been establish to have little poisonousness to man, but long ingesting of large dosages can result in some health problems such as tiredness, dizziness, and neutropenia (Hess and Schmid, 2002).

Environmental and health challenge is one major concern related to animal effluents, the introduction of pollutants, including nutrients (for instance nitrogen and phosphorous), organic matter, sediments, pathogens (such as microorganisms and diseases), and substantial chemicals. These contaminants certainly adversely impact water quality and could pose severe threats to community health by polluting drinking water provisions. Nutrients, mainly phosphorous and nitrogen, quicken eutrophication of water bodies Mallin (2000) and upsurge the biological load (biochemical oxygen demand) (Webb and Archer, 1994). The concentration of excess nutrients and decomposing carbon-based matter in water can result in little liquefied oxygen and algal blooms. However, the reduction of liquefied oxygen levels might kill fish (Oldham *et al*., 2000).

In modern ages, livestock farming has also been implicated in epidemics of waterborne diseases in North America (Environmental Manual for Poultry Practice in Alberta, 2003). Ajayi *et al.* (2003) observed rises in water contamination indices in groundwater samples collected close to a poultry production in Akure, Ondo. A positive association between poultry compost and water contamination due to nitrate and phosphate additions has been established by Adeyeye and Abulude (2004).

2.11 Research Framework for Determining Environmental Impacts of Poultry Farms in Kuje Suburbia.

The research framework for determining Environmental Impacts of Poultry farms in Kuje will be determined through laboratory test of water quality and soil and ambient air quality will be carried out to determine the environmental impacts of poultry farms on residents in the study area. Water quality Parameters such as pH, Conductivity, Total Alkalinity (TA), Total Hardness (TH), Cloride (Cl), Nitrate (NO3), Phosphate (PO4), Nitrite (NO2), Sodium (Na), Potassium (K), Biochemical Oxygen Demand (BOD), Manganese (Mn), Copper (Cu), Lead (Pb) and Zinc (Zn) to determine the impacts.

Similarly, soil test parameters such as pH, Conductivity(µs), Organic Carbon (OC), Organic Matter (OM), Total Nitrogen (TN), Calcium (Ca), Manganese (Mg), Sodium (Na), Potassium (K), Effective Catio Exchange Capacity (ECEC), Exchangeable Acidity (EXA), Manganese (Mn), Copper (Cu), Lead (Pb) and Zinc (Zn). And the ambient air quality parameters; Carbon monoxide, Ozone, Nitrogen dioxide, Sulphur dioxide.

Taiwo *et al*. (2013) revealed that little is recognised about the impacts of poultry production on the water and residue potentials. Poultry waste in stream water helps in the growth of nutrient, solid and chemical loads of surface water quality, thus, leads to algae bloom, compact bright infiltration, enlarged turbidity, bioaccumulation of poisonous metals and disturbance of environment. Poultry compost is the major contaminant related related to poultry farm processes, which on decay decreases oxygen levels of a river and cause fish loss. Other ecological dangers and irritations related to poultry processes include odour, dust and gases, insecticides, medicinal and pathogens (Anon, 2018).

Edwards (1997) in their studies indicated that, the unnecessary releases of nitrogen, phosphorus, zinc and copper by poultry litters come from surplus provisions of protein and phosphorus in poultry production and also through physiologically insufficient use of vital trace components. Richardson (1997) went further to reveal that, this might negatively impact both the aquatic and terrestrial environments.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

The study adopts a triangulation approach involving the practice of using multiple sources of data or multiple methods to evaluating data to improve the reliability of a research work. The study employed geospatial, experimental and quantitative approaches to address the research questions for this study.

First, the study used GIS to identify and map poultry farms and production capacity in the study area. Secondly, this study adopts experimental approach through a laboratory sample test and measurement to assess the impacts of the poultry farms production activities on the environment. This includes the impact of poultry farm on surface water, soil and the ambient air quality in the study area.

Finally, the survey research design adopted quantitative research approach based on field surveys employing self-administration questionnaire to examine the resident perception of the poultry farms activities in the study area, and also the nature and level of complaints by residents in Kuje suburbia. Figure 3.1 summarises the research process in the light of the data required to achieve the aim and objectives of the study.

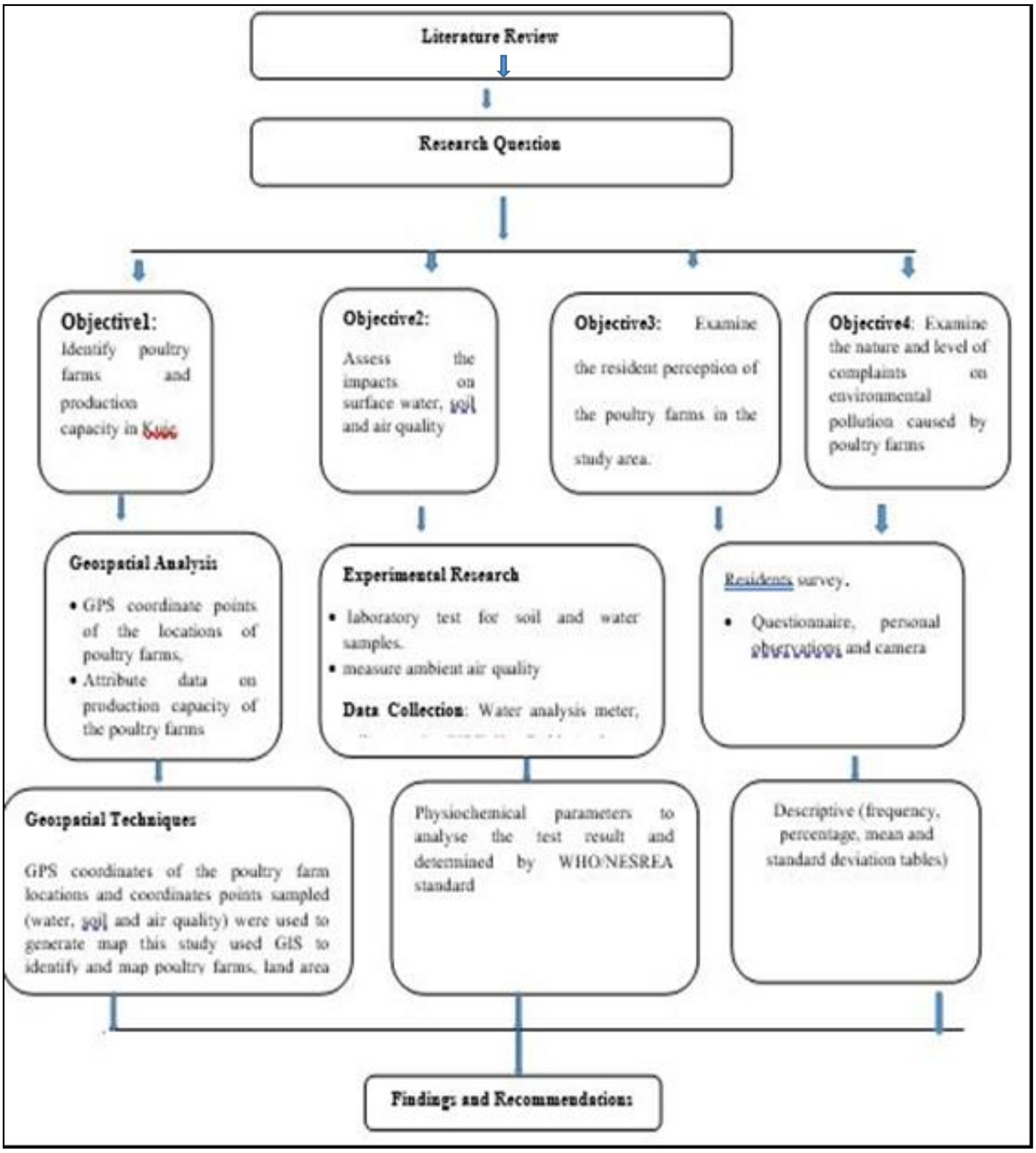

Figure 3.1: Research Conceptual Framework
Source: Author's Design, (2020)

3.2 Method of Data Collection.

3.2.1 Geospatial data collection

Geospatial data: identifying and mapping poultry farms and production capacity, locational positions and images in the study area.

3.2.1.1 Data collection

3.2.1.2 Data analysis (geospatial analysis techniques)

Geospatial data were used to identify and map poultry farms production capacity, mapping the distance from the poultry farms and determine the impacts on residents. locational data images of poultry farms in the study area. The acquired data was analysed using GIS.

3.2.2 Experimental data collection

3.2.2.1 Sample data collection (water, soil and air)

Water samples for physiochemical properties were collected with clean pre-washed three (3) litre bottles for surface water, borehole and well water using hand sampling method. purposive sampling was applied to create the sampling points of borehole water and well water based on nearness to residents while the river/surface water is the only existing one. During the sampling, the three bottles were initially washed with the sampled water before the actual sampling. Samples of water were collected one (1) litre each making total of three (3) bottles labelled surface water, borehole water and well water respectively. The following parameters were measured using (Standard Methods), 19th edition, APHA, AWWA, WEF, 1995 for water analysis: pH, Conductivity, Calcium, Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO3), Phosphate (PO4), Sodium (Na), Potassium (K), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) Manganese (Mn) and Total Dissolved Solids (TDS).

These were determined according to standard methods in the Central Services Laboratory of the Department of Water Resource and Soil Sciences Federal University of Technology Minna, Niger State laboratory.

The Soil Sample fetched were measured in four (4) plastic leather at an interval of 20meters, 40meter, 60meters and 200 meters which was also labelled Soil A, Soil B, Soil C and Soil D. The parameters tested for the Surface water, Borehole water and Well Water sample are pH, Conductivity, Total Hardness, Nitrate, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solid (TDS), Calcium, Manganese, Dissolved Oxygen (DO), Sodium, Phosphate and Potassium. Also parameters sampled for the soil quality are Soil pH, Conductivity (siemens), Total Organic Carbon, Organic Matters, Calcium, Manganese, Sodium, Potassium, Total Nitrogen and Lead as in parameters soil sampled at appendix B.

These were determined according to standard methods in the Central Services Laboratory of the Department of Water Resource and Soil Sciences Federal University of Technology Minna, Niger laboratory. Coordinates of sampled points locations are in Table 3.1 and 3.2.

Table 3.1 Water Sampled Points with Coordinates

s/n	Sample code	Coordinates
1	Surface water	0299850^{o}E 0984437^{o}N
2	Borehole water	0299930^{o}E 0984011^{o}N
3	Well water	0299875^{o}E 0984320^{o}N

Source: Author’s Field Survey, (2020)

Table 3.2: Soil Sampled Points and Coordinates

S/no	Sample code	Coordinates
1	Soil A (20m)	299844°E; 983955°N
2	Soil B (40m)	299847°E; 983966°N
3	Soil C (60m)	299881°E; 984313°N
4	SoilD(200m)	300223°E; 983969°N

Source: Author's Field Survey, 2020

3.2.3 Survey data collection

Data on water, soil and air were collected for laboratory test. PCE-RCM 0.5 and Crowcon Gasman CO_2 meter was used to observe CO_2, PM2.5 and SO2 emission from the study area, GPS were used to take coordinates of each poultry farm locations, sample points for (Surface water, Borehole water and Well water), Soil sample points and Air Quality sample points. Also plastic bottle and plastic leather were used for the collection of samples from the study area for laboratory analysis. Questionnaire was structured to collect data on resident's perception of the farms activities in the study area and nature and level of complaints on environmental pollution caused by poultry farms.

3.2.3.1 Population frame

The population of this study involves all the residents in Kuje Suburbia with population of 2,464 as stated by National population commission of 2006 National Census. This population was projected from 2006 to 2020 using exponential formula as follow;

$Pn = Po\ (1+r/100)^{n}$ where (3.1)

Pn = Expected population =?

Po = Base population = 2,464

r = Growth rate = 3.63%

n = Number of years = 14years

:. $Pn = 2,464\ (1 + 3.63/_{100})^{14}$

$$2{,}464\,(1 + 0.036)^{14}$$
$$2{,}464(1.036)^{14}$$
$$2{,}464\,(1.6407)$$
$$Pn = 4{,}042 \text{ people}$$

Hence, 4,042 is divided by 5 to arrive at 808 households which represent the sample frame for the study.

3.2.3.2 Sample size and techniques

Dillman's (2007) formula was adopted to get the sample size for this study in order to estimate a desired sample size from a given population this includes;

$$Ns = \frac{(Np)(p)(1-p)}{(Np-1)(\frac{B}{C})^2 + (p)(1-p)} \qquad (3.2)$$

Where; Ns = completed size needed (representation frequently used is n)

Np = population size expected (representation frequently used is N)

P = proportion expected to respond to questions (50% or 0.05 is most conventional)

B = acceptable degree of error in sampling (0.05 = ±5%; 0.03 =± 3%)

C = Z statistic associated with confidence interval (1.645 = 90% confidence level; 1.960 = 95% confidence level; 2.576 = 99% confidence level)

Hence;

$$Ns = \frac{(808)(0.5)(1-0.5)}{(808-1)(\frac{0.05}{2.576})^2 + (0.5)(1-0.5)}$$

$$Ns = \frac{201}{(808-1)(\frac{0.05}{2.576})^2 + (0.5)(1-0.5)}$$

$$Ns = \frac{201}{0.55932}$$

$$Ns = 360$$

Therefore, 360 households were used as sample size for the study.

3.2.3.3 Instrument of data collection (questionnaire)

Samples of water were collected one (1) litre each making total of three (3) bottles labelled surface water, borehole water and well water respectively. Equally, The Soil Sample fetched were measured in four (4) plastic leather. Questionnaire was structured which was used to collect data on demographic, socio-economic characteristics on residents in Kuje Subrbia. The data was collected using questionnaire which addresses the opinions and perceptions of residents on environmental impacts of poultry farm activities, nature and level of complaints on environmental pollution caused by poultry farms.

3.2.3.4 Data analysis techniques

The data obtained through field survey was collected by means of various data analytical techniques. The study sampling technique comprises of two-stage procedure. The first stage involved the random selection of poultry farms in Kuje Suburbia based on scale of operation (large scale) and production while the second stage involved a purposive selection of the nearest to residents to each of the sampled poultry farms within a distance of 500 metres from the farms and also indigenes of the residents so as to ensure every element of the population have an equal and independent chance of being included in the sample for questionnaire administration. Also some respondents or leaders of the community were selected for questionnaire administration to know the level of complaints laid to the government and Kuje Area Council on the environmental impacts of poultry farms in Kuje suburbia.

The water samples collected were subjected to an analysis which revealed its Physio-Chemical characteristics. From the result of the analysis of the sampled water collected of three different sources around the study area, labelled as thus; Stream water, Borehole water and Well water samples. The sample points are located East and North of both Sarki and Premium farms. The water sampled at the three different locations were determined according to standard methods in the Central Services Laboratory of the Department of Water Resource and Soil Sciences Federal University of Technology Minna and were subjected to the following parameters: pH, Conductivity, Total Hardness, Total Dissolve Solids (TDS), Calcium, Manganese, Sodium, Potassium, Phosphate, Nitrate, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

The Soil Quality samples collected were also subjected to analysis which revealed its Physio-Chemical characteristics. The result of the analysis of the sampled soil collected at four different locations Soil (A)20meters, Soil(B) 40meters, Soil(C) 60meters and Soil(D) 200meters away from the poultry fence.

The Soil sampled at the four different locations were also determined according to standard methods in the Central Services Laboratory of the Department of Water Resource and Soil Sciences Federal University of Technology Minna and were subjected to the following parameters: pH, Conductivity, Organic Carbon. Organic Matter, Calcium, Manganese, Sodium, Potassium, Total Nitrogen and Lead.

The Air Quality were measured at three different locations 20meters, 40meters and 60meters away from the fence of both poultry farms (Sarki and Premium farms) making total of six different locations. Also, air pollutants gases that can be usually observed in relative to air quality are: Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), Suspended Particulate Matter (SPM), Ammonia (NH^3), Hydrogen Sulphide (H_2S) and Carbon Monoxide (CO).

The air quality level was measured using MSA Altair 5× Multigas Detector with model SW 1.27.06.50, a moveable handheld device used to determine the presence of gases in the environment. The device is capable of reading five gases Carbon Monoxide ($CO2$), Combustion gases (methane and methane), Nitrogen Sulphite and Oxygen volume in the air. But as for this research, it was only $CO2$ that were measured, as indicated in Plate I.

Plate I: MSA Altair 5× Multigas Detector
Source: Author's Field Analysis, (2020)

The PCE-RCM 0.5 air quality meter was also used to measure the concentration of pollutants. The device is available with a maximum of two sensors which can display the readings of two gases particulate matter (PM2.5) and Sulphur Dioxide ($SO2$). For this research, the two gases were measured. See in plate II.

Plate II: PCE-RCM 0.5 meter
Source: Author's Field Analysis, 2020

The time frame for data collection were in three (3) sampling time; before, during and after production for CO2, but the sampling time for PM2.5 and SO2 were before and after production. The air quality was measured at interval of 20 meter, 40meter and 60meters away from the two (2) poultry farms. Also, other pollutants that can be commonly measured in relation to air quality are; Ammonia (NH3) and Hydrogen Sulphide as in appendix C. But for this study, only Particulate Matter (PM2.5), Sulphur and Carbon Monoxide (CO2) were measured; others are to be measured in the further research. The Air Quality results were tested within WHO and (NESREA)'s regulatory guidelines. The parameters measured are; Sulphur Dioxide (SO_2), Suspended Particulate Matter (SPM) and Carbon Monoxide (CO2).

3.3 Methods of Data Presentation

The analysed data from this research work was presented with the aid of tables. Similarly, the location maps of the poultry farms using GIS was presented as Figures. The socioeconomic and demographic data, resident's perception of the poultry farms and nature and level of complaints on environmental pollution caused by poultry farm activities data was presented using tables. Relevant pictures taken during the physical/personal observation was presented as Plates.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Identify Poultry Farms and Production Capacity in Kuje Suburbia

4.1.1 Socio-economic characteristics of the respondents

More than half (60%) of the respondents from the study area were male. Age range 31-40 years (51.4%) was the highest. This implies that residents in Kuje Sburbia were predominantly young people. Also, more than half (50.6 %) were married. This implies that, residents have family responsibilities. Likely environmental pollution that may arise from the poultry farms might increase their vulnerability to more responsibility of sickness treatment. Table 4.1 further shows that, 15.3% had primary education,33.6% of the respondents had secondary education, 20.8% are non-graduates and 24.2% are graduates.

This implies that the literacy level of the farm was average. This potential may influence their complaints towards environmental issues such as pollution from the poultry farms. The predominant occupation of the residents in the study area was business (36.7%) and farming (25.8%). Highest percentage years of residence in the study area was 39.2% and 30.3%. This implies that most of the residence are indigenes in the study area as all shown in Table 4.1. The finding suggests that environmental pollution could be one of the reasons the greater percentage of the residents are indigenes which also hindered development in the study area.

Table 4.1: Socio-Economic Characteristics

Gender	Frequency	Percentage
Male	216	60
Female	144	40
Total	360	100
Age		
Under 20	25	6.9
21-30	100	27.8
31-40	185	51.4
41-50	31	8.6
51-60	19	5.3
Total	360	100
Marital Status		
Single	140	38.9
Married	182	50.6
Widowed	38	10.6
Total	360	100
Level of Education		
Primary	55	15.3
Secondary	121	33.6
Graduate	87	24.2
Non Graduate	75	20.8
Others	22	6.1
Total	360	100.0
Occupation		
Farming	93	25.8
Trading	29	8.1
Business	132	36.7
House wife	25	6.9
Civil servant	81	22.5
Total	360	100
Years as residence		
Below 5	45	12.5
5- 10	142	39.2
11 -15	65	18.1
16 and Above	109	30.3
Total	360	100
Number of Poultry Around your Area.		
< 5	331	91.9
5 – 10	29	8.1
10 – 15	0	0
>15	0	0
Total	360	100

4.1.2 Poultry farms and production capacity in the study area.

The poultry farms in Kuje sub-urbian and production capacity were identified, six (6) poultry farm where identified in Kuje sub-urbian, even though, some of this poultry farms have long been abandoned and no longer operating while six (6) are operating and in large production capacity. It was found that, the farms produce mostly layers and broilers birds, some of these poultry farms are a bit distance from residents with about 1km to 3km. Even though from the survey carryout, Sarki farms and Premium farms are few farms that are closely located to residence, which are basically the source of environmental pollution or hazard in the study area. Equally it was identified that farm A is 0.5km away from the residence while farm B is 0.04km, the other four (4) farms are far located from built up areas. And the farms scale of productions is medium and large scale. Farm A has the highest number of birds raise (over a million), farm B raise above 300,000, Farm C above 150,00, Farm D above 400,000, Farm E above 200,000 and Farm F above 50,000. It was found that, Farm A and Farm D are integrated poultry farms (they store, produce chicken feeds and raised birds. The agro capacity production of Farm A, is the production of 50 bags of chicken feeds daily and Farm B 100bags of chicken feeds weekly.

The land area of the farms is as follow; Farm A (13.11hectare), Farm B (7.24hectre), Farm C (6.83 hectare), Farm D (5.89hectare), Farm E (5.29) and Farm F (4.75hectre) as in table 4.2. The poultry farms operate in battery cage system; the poultry mechanization were also identified. Lastly, it was identified that the poultry farms (lands) were allocated to them by Kuje Area Council and are private owned. Farm A, D and E are registered with the Ministry of Environment.) as in table 4.2, figure 4.1 and 4.2 shows the satellite imagery of the identified farms.

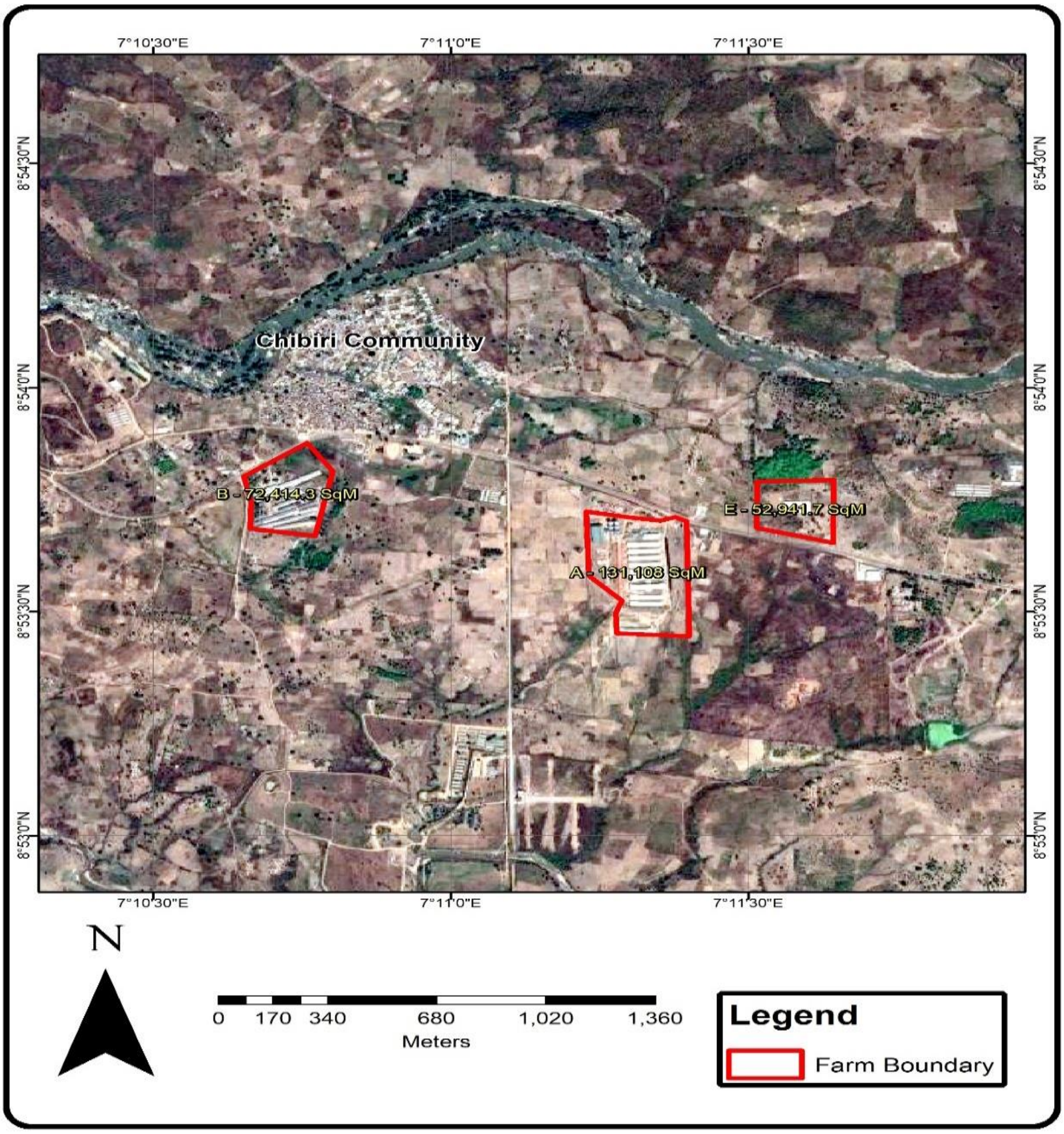

Figure 4.1: Satellite Imagery of Farm A, B and E Locations
Source: Author's Field Survey, 2020

Plate III: View of farm A and Farm B
Source: Author’s Field Survey, 2020

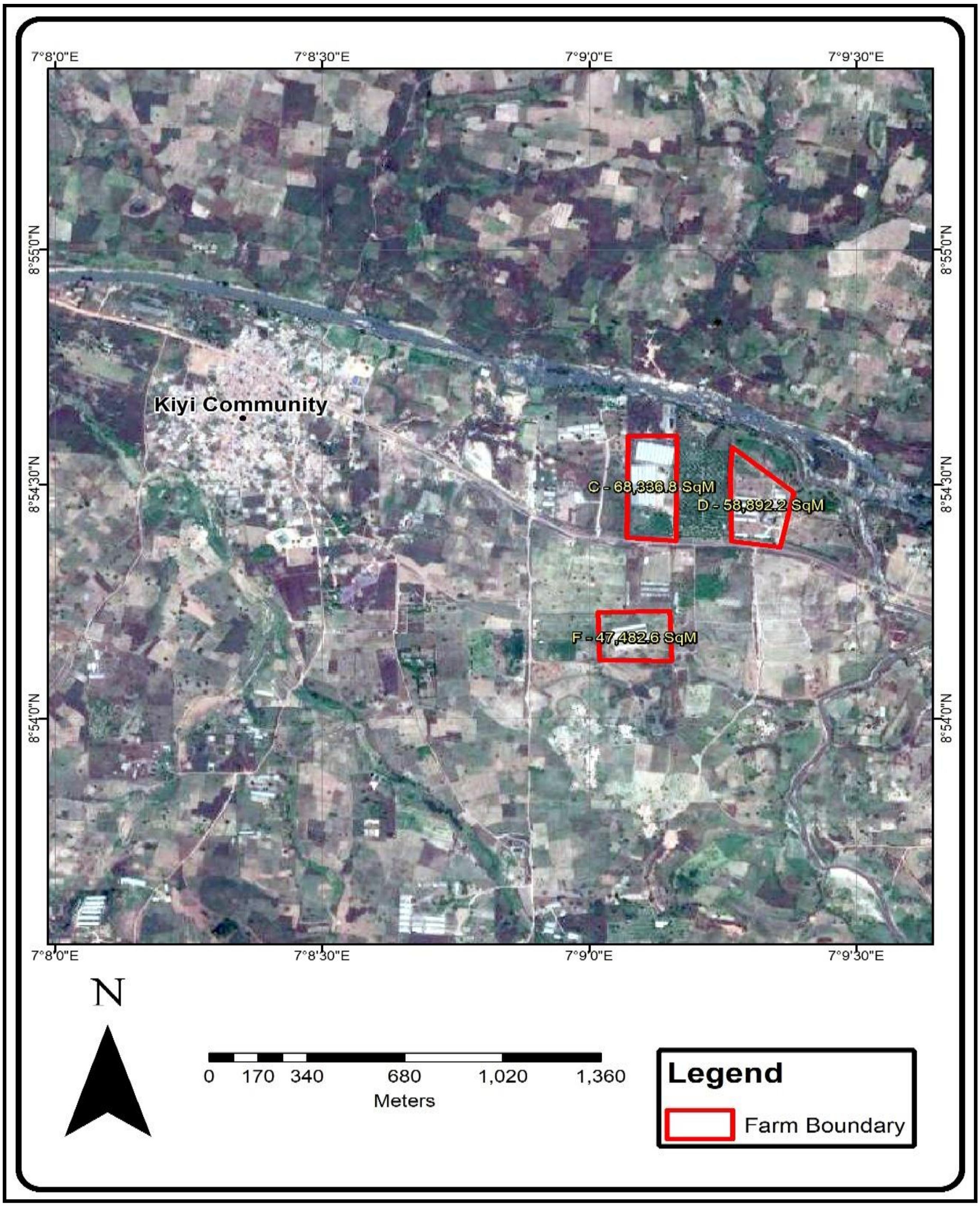

Figure 4.2: Satellite Imagery of Farm C, D and F Locations
Source: Author's Field Survey, (2020)

4.2 Impact of Poultry Farm on Surface Water, Soil and Air Quality

The impact of poultry farms on surface water, soil and air quality in Kuje suburbia were measured and determined using standards and guidelines described by the World Health Organization (WHO; 2011), National Environmental Standard and Regulation

Enforcement Agency (NESREA ;2011) and Federal Ministry of Environment (FMENV; 2008).

4.2.1.1 Physiochemical parameters of water quality

Figure 5 shows the different locations of water sampled at the study area. Water sample was taken from three (3) sources of water (stream/surface water, borehole water and well water). The result of the laboratory test is presented in table 4.3. The result for each physiochemical parameter are discuss below in the subsection.

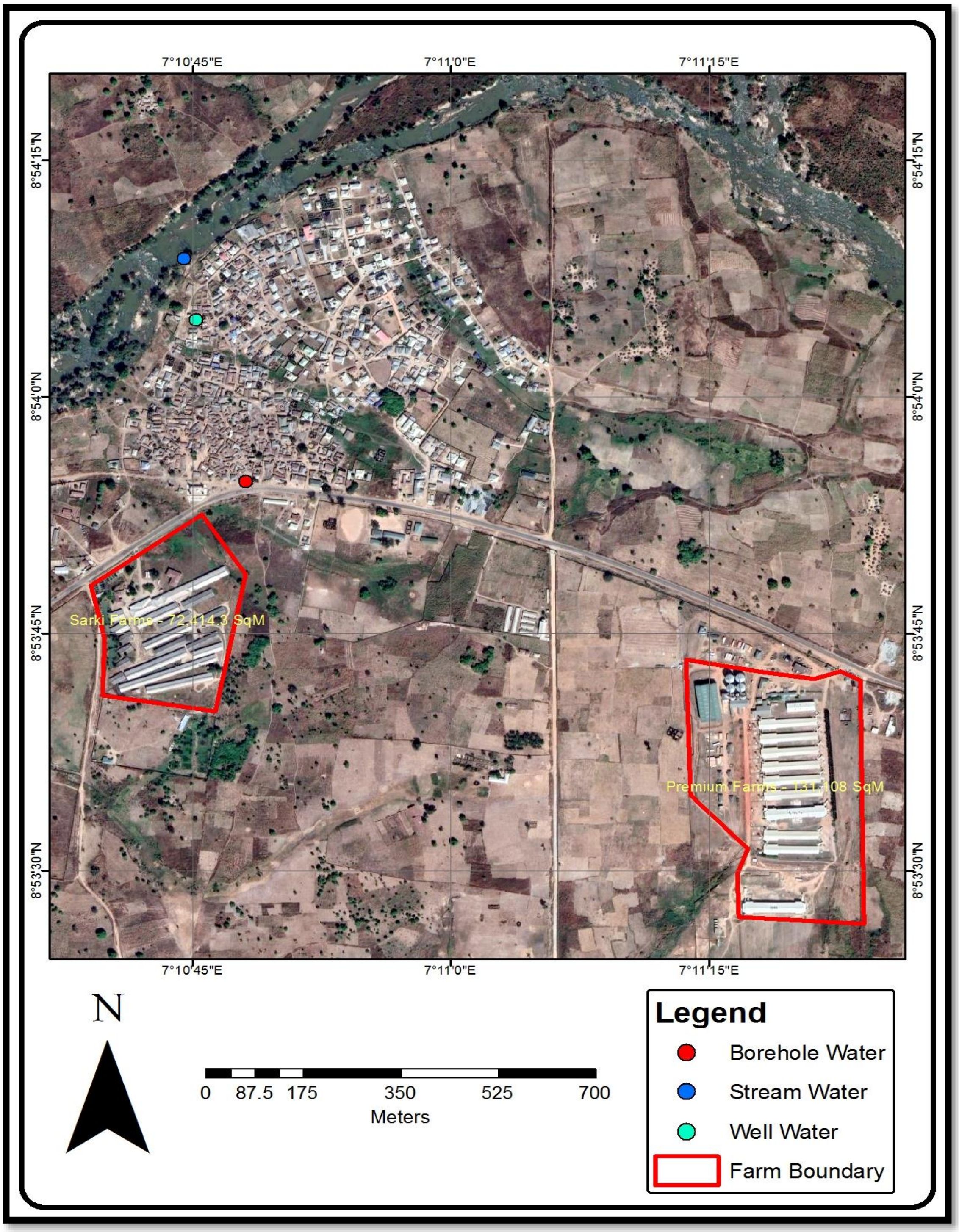

Figure 4.3: Satellite Imagery of Water Sampled Locations
Source: Author's Field Survey, (2020)

Table 4.2: Results of the Physiochemical Parameters of the Analysed Mean Stream, Borehole and Well Water Sampled

PARAMETERS	MEAN STREAM WATER SAMPLE	MEAN BOREHOLE WATER SAMPLE	MEAN WELL WATER SAMPLE	WHO/NESREA GUIDELINES
pH	6.73	6.82	6.76	6.5-8.5
Conductivity	148uSiemen	304uSiemen	388uSiemen	1000uSiemen
Total Hardness (TH)	50 mg/l	65mg/1	70mg/1	50-200mg/1
Total Alkalinity	82mg/1	169mg/1	45mg/1	<5.5mg/1
Calcium	21.09mg/l	37.82mg/1	42.1mg/	75mg/1
Manganese	7.12mg/l	6.64mg/1	6.80mg/1	0.05-0.5mg/1
Sodium	2.83mg/l	5.96mg/1	3.54mg/1	200mg/1
Potassium	0.66	1.44mg/1	0.78mg/1	200mg/1
Phosphate	0.13mg/1	2.24mg/1	1.94mg/1	0.5mg/1
Nitrate	2.19mg/1	3.44mg/1	5.6mg/1	0.2mg/1
BOD	6.76mg/1	3.50mg/1	8.27mg/1	5mg/1
COD	9.23mg/1	16.65mg/1	16.65mg/1	80mg/1
TDS	31.46mg/l	64.71mg/l	93.63 mg/l	5.5mg/l
	LAT: 299850°E **LOG: 984437°N**	**LAT: 299930°E** **LOG: 9840110° N**	**LAT: 299875° E** **LOG:984320°N**	

4.2.1.2 pH value

The pH values in Table 4.2 results obtained from the laboratory test with the mean value for Stream water (6.73), mean Borehole water (6.78) and mean Well water sampled (6.76) respectively; lower pH indicates increasing acidity while higher pH values indicate increasing alkalinity. The pH of this study has shown that it is higher pH value indicating alkalinity and within the WHO/NESREA standard whose acceptable limit is 6.5-8.5 for drinking water.

4.2.1.3 Conductivity

The mean concentration (stream water 148uSiemen, borehole water 304uSiemen and well water 388uSiemen) of Conductivity is shown in table 4.3.2. This result shows that there was not high salinity of hazard in the study at the time the samples were collected. This implies that the values of conductivity being within the permissible limit by water quality standard guidelines for various uses of 900uSiemen by WHO/NESREA.

4.2.1.4 Total hardness (TH)

The mean concentration (stream water 50mg/l, borehole water 65mg/1 and well water 70mg/1) of Total hardness as seen in table 4.3.2, the test analysis revealed that the concentration of Total hardness in all the sampled water were within the permissible limit of 50 – 200mg/1. Total hardness is the sum of the calcium and magnesium concentrations, it is determined based on the concentration of calcium carbonate: below 75mgl is generally considered soft, 76 to 150mg/l moderately hard and 151 to 300mg/1 hard. This implies that the concentration of Total hardness in water quality does not pose any adverse effect in the study area.

4.2.1.5 Total alkalinity (TA)

The laboratory test results of Total Alkalinity obtained, mean stream water 82mg/1, mean borehole 165mg/1 and mean well water 45mg/1 respectively. Alkalinity is the quantitative capacity of a sample to neutralize a strong acid to a designed pH Alkalinity is important in the treatment of natural and waste water. The result shows that the high presence of metals present in the water quality at the study area is as a result of the poultry activities and the result proof that it is above the standard guidelines of <5.5mg/l by WHO/NESREA.

4.2.1.6 Calcium (Ca)

Calcium is seen to be the fifth (5^{th}) and richest elements present in natural water between the level of zero milligrams per liters. It contributed to the rigidity properties of water and test results usually are reported as calcium hardness mg/l. Calcium is good for human, animals and plants. But high content of it ranges from 2, 5grams daily, its can result to growth of kidney stones and sclerosis of kidneys and blood vessels (Pallar *et al.,* 2020). The minimum allow of calcium content in water is (75mg/l). From table

4.3.2 it was observed that Calcium was found in the three sources of water tested mean stream water (21.09mg/1), mean borehole (37.82mg/1) and mean 42.1mg/1) which are within WHO acceptable limits of (75mg/1).

4.2.1.7 Manganese (Mn)

The mean concentration of Manganese is (7.12mg/l, 6.64mg/1 and 6.80mg/l), the three (3) water sampled are above the maximum allowable limit for water standards as shown in table 4.3. Manganese is considered as a lead to aesthetic problems like taste, odour, colour, slime and low pressure. The occurrence of Manganese (Mn) in public water supplies causes dark stains in laundry and on plumbing fixtures, tends to deposit lines water. It also impacts an objectionable taste to beverages like coffee and tea. (Paul *et al*, 2016). Exposure to high concentrations of Manganese is unlikely to produce toxicity such as cancer or reproductive damage. (Manikannan *et al.*,2011). This implies that the high concentrations of Manganese in all the three sampled water have adverse effect on the study area.

4.2.1.8 Sodium (Na)

The mean concentration of Sodium (Na) from the test analysis (2.83mg/l, 5.96mg/l and 3.54mg/l) are within the WHO recommended standard of 200mg/l. Sodium ion is abundant in water, due to the high solubility of its salts and the plenty of sodium-containing inorganic deposits. Salt-water has approximately 30,000 mg of sodium chloride per litre (mg/L). Underground water characteristically has higher presence of inorganic and salts than stream waters, particularly in regions with plenty of sodium inorganic deposits or in parts with aquatic or estuarine water disturbances (WHO, 2009).

4.2.1.9 Nitrate (NO3)

The mean concentration of nitrate is (2.19mg/l, 3.44mg/1 and 5.16mg/l) for the three (3) water sampled are above the maximum allowable limit for water standards as shown in table 4.3 Surplus levels of nitrates in water can generate circumstances that make it hard for aquatic animals to live. (Manikannan *et al.,* 2011). Presence of Nitrate above 10 mg/l are observed dangerous and can lead to methemoglobinemia in new-borns under six months as well as other health effects, such as diarrhoea and respiratory sicknesses (Ward *et al.,* 2005).

4.2.1.10 Phosphates (PO4)

The mean phosphates values obtained are (0.13mg/1, 2.24mg/1 and 1.94mg/1) and the maximum allowed limits for water quality use is 0.5mg/1(WHO) as shown in table 4.3. This result shows that the PO_4 concentration levels of stream, borehole and well water in the study area have exceeded the permissible limit set up by quality of water standards as shown in Table 4.3. The presence of phosphorous in underground water have effect surface water quality particularly during the period of little rain when the mainstream of movement in the streams is base flow during the growing season. (Heather *et al.,* 2010). This indicates that the high presence of PO4 in water sampled in Kuje suburbia could affect the availability of surface water during the dry season.

4.2.1.11 Potassium (K)

It was also observed from table 4.3 that, Potassium in water sampled were far below the WHO/NESREA guidelines, the standard set is 200mg/l, while all value of Potassium in Kuje suburbia are in the range of (0.66mg/l, 1.44mg/l and 0.78mg/l). This implies that the content of Potassium was found low because the poultry activities doesn’t have any adverse effect in the study area.

4.2.1.12 Biochemical oxygen demand (BOD)

As shown in table 4.3.2, the mean values of BOD gotten from the laboratory test are stream water (6.76mg/1), borehole water (3.50mg/1) and well water (8.27mg/1) and the maximum allowable limit is 5mg/1, indicating that BOD concentrations levels are above the stated limit of water quality standards. When the presence of Biochemical Oxygen Demand is in high levels it shows that the water is contaminated, and less of Bod shows the quality of water is good.

4.2.1.13 Chemical oxygen demand (COD)

The mean concentration of Chemical Oxygen Demand (9.23mg/l, 16.65mg/l and 16.65mg/l) respectively. Oyem *et al*, (2014) revealed that the Chemical Oxygen Demand (COD) is credibility to the cleanliness of the water, inferring however, gain exact insignificant organic concentration, interpreting by implication to good taste, odour and aesthetic quality

4.2.1.14 Total dissolved oxygen demand (TDS)

The mean Total Dissolved Oxygen Demand (TDS) values obtained are surface=31.36mg/l, borehole water = 64.71 and well =93.63mg/l and the maximum allowed limits for water quality use is 500mg/1(WHO) as shown in table 4.3. The results indicate they are within the standard guidelines for drinking water by WHO/NESREA. Excessive Total Dissolved Solids (TDS) could to yield poisonous effect on human and animals. Its shows contamination of water (Oyem *et al*,2014). The objects in water come from liquefied and suspended matter. Water with high objects substances have lower palatability and may induce adverse physical response in some consumers. Water with high solids contents may also be unsuitable for some industrial use. Which most not exceed the permissible limits of (500mg/l).

4.2.2 Physiochemical characteristics of the soil quality

The soil samples collected were subjected to analysis of its Physio-Chemical characteristics. The parameters subjected to test or analysis are; pH, Conductivity, Organic Carbon, Organic Matter, Total Nitrogen, Calcium, Magnesium, Sodium, Potassium and Lead. The samples were collected from four different locations around the study area at 20meters, 40meters, 60meters away from the poultry farm respectively as shown in Soil sampled locational map figure 4.4. the result of the soil test is presented in table 4.4. the result show that from soil A, B, C and D. calcium has about 5mg/kg, manganese has 200g/kg and lead 0.01-1.0mg/kg. Which show that the result is above the recommended standard by WHO.

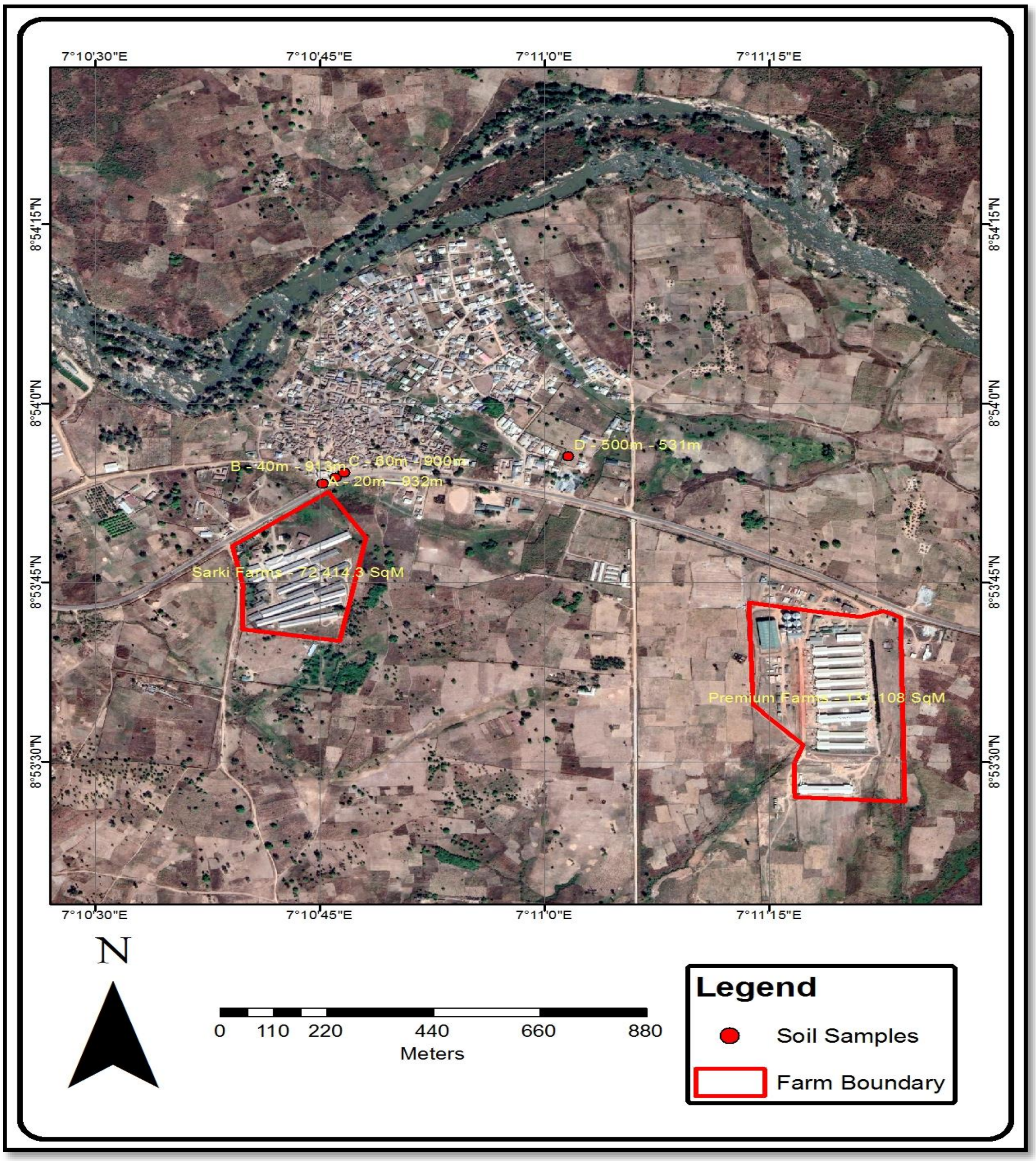

Figure 4.4: Satellite Imagery of Soil Sampled Locations
Source: Author's Field Survey, (2020)

Table:4.3: Results of the Physiochemical and Microbiological Parameters of the Analysed Soil A, B, C and D Sampled.

S/N	PARAMETERS	SOURCES				WHO/ NESREA GUIDELINES
		SOIL A (20m)	**SOIL B (40m)**	**SOIL C (60m)**	**SOIL D (200m)**	
1	pH	7.53	7.66	7.58	8.04	6.5-9.2
2	Conductivity	371	255	332	302	960µ
3	Organic Carbon	2.15	0.57	1.3	0.79	1.5-5.0%
4	Organic Matter	3.69	0.98	2.24	1.36	1-5g/kg
5	Calcium	**680**	**572**	**702**	**570**	75g/kg
6	Manganese	**141.52**	**104.92**	**146.4**	**185.44**	5mg/kg
7	Sodium	50.6	32.2	41.4	29.9	200mg/kg
8	Potassium	31.2	11.7	23.4	15.6	200g/kg
9	Total Nitrogen	0.35	0.2	0.25	0.28	10g/kg
10	Lead	**4.42**	**2.16**	**4.1**	**3.65**	0.01-1.0mg/kg
		LAT :299844 LOG :983955	**LAT :299847 LOG :983996**	**LAT :299881 LOG :984313**	**LAT :300223 LOG :983969**	

4.2.2.1 pH value

pH is a quantitative measure of the acidity or basicity of a soil. Analysis in figure 6 shows the four basic locations of soil sample, Soil (A), Soil (B), Soil (C) and Soil (D). The samples were also taken at an interval of 20meters, 40meters and 60meters. pH value in all the sampled collected were within WHO/NESERA guidelines of 6.5 - 8.5. Soil pH is the factor that affects the accessibility of anions to plants (Peles *et al.*, 2017). It also has various chemical impacts both in the physiological of plant and man. In plants, some anions are involved in the control of water of loss salt impact.

According to Peles *et al.* (2017), acid soil has a pH value below 7 while alkaline soil has a pH value above 7Ultra-acidic soils (pH < 3.5) and very strongly alkaline soils (pH > 9) are rare. Acidic soils (pH < 3.5) and very strongly alkaline soils (pH > 9) are rare. This implies that, the pH content of soil in all the sampled soil as shown in table 4.4 were alkaline above 7 which does not pose any significant health challenge or affects their plants in the study area.

4.2.2.2 Conductivity

Conductivity is a measure of how well a solution conducts electricity. Analysis of Table 4.4 revealed the conductivity value of Soil (A), Soil (B), Soil (C) and Soil (D). The conductivity value in all the sampled collected were within the WHO/NESREA guidelines. The samples were also taken at 20meters, 40meters and 40 meters' interval.

4.2.2.3 Organic carbon

Organic carbon is an amount of the carbon limited within soil carbon-based matter. The analysis in table 4.4 shows that organic carbon content in all the soil sampled collected in the study area were within WHO/NESERA permissible limits for organic carbon 1.5-5.0g/kg. Only the sampled Soil (B) and Soil (D) within 40meters location were far below the standard which are 0.57g/kg and 0.79g/kg, this shows the level of the contamination at 20meters soil sampled collected.

4.2.2.4 Organic matter

Organic matter is refered to as the large pond of organic matter which can be found within natural and engineered, earthly and water surroundings. It was discovered from the test analysis in table 4.4 that the soil sampled collected at three locations 3.69g/kg, 0.98g/kg, 2.24g/kg and 1.36g/kg at interval of 40meters and 60meters are within the standard, while the other remaining location point at 20 meters away has the content of the organic matter, which the contamination level, though its negligible, since is still within the standard of 1-5g/kg.

4.2.2.5 Calcium (Ca)

The level of Calcium was also examined in soil sampled in the study area, it was discovered from the test analysis in table 4.4 that the soil sampled collected at 20meters, 40meters, 60meters respectively 680g/kg, 572g/kg, 702g/kg and 570g/kg were all very higher above the standard, which is a sign of fertility in plants.

4.2.2.6 Manganese (Mn)

The test or analysis of soil A, B, C and D of 141.52mg/1, 104.92mg/1, 146.4mg/1 and 185.4mg/1 shows that it is high and far above the WHO/NESREA standards of 5mg/1. Manganese is seen as a lead to aesthetic problems like taste, odour, colour, slime and low pressure. They are considered secondary contamination that has little effect on public health when concentrated in underground water as the divalent ion due to the absence of sub surface oxygen.

4.2.2.7 Sodium (Na)

The level of Sodium was also examined in soil sampled in the study area, it was discovered from table 4.4 the values of Sodium in soil, 50.6g/kg, 32.2g/kg, 41.4g/kg and 29.9g/kg were all higher than WHO/NESREA guidelines of 1.3g/kg. This is an indication that the high content of Sodium in soil is due to the poultry activities in Kuje suburbia

4.2.2.8 Potassium (K)

It was also observed from table 4.4 that, Potassium in soil sampled were far below the WHO/NESREA guidelines, the standard set is 200g/kg, while all value of Potassium in the study area are ranging from 31.2/kg, 11.7g/kg, 23.4g/kg and 15.6g/kg. This implies that the content of Potassium was found low because the poultry activities does not have any adverse effect in the study area.

4.2.2.9 Total nitrogen (Tn)

Total Nitrogen in the soil sampled test A, B, C and D shows 0.35g/kg, 0.2g/kg, 0.25g/kg and 0.28g/kg was far below WHO/NESREA standards of Nitrogen content in the soil of 10g/kg. However, this is an indication that the poultry production does not pose any negative effects in the study area.

4.2.2.10 Lead (Pb)

Lead in the soil sampled was recorded as 4.42kg, 2.16kg, 4.1kg and 3.65kg for soil A, B, C and D which is above WHO/NESREA standard of 0.01-1.0kg. Lead occurs due to social activities such as mining, industrial and fossil fuel burning, which results in accumulation of lead and its compound in the environment, including water and soil. Lead is a severe venom, tends to gather in bone structure when consumed in levels beyond the usual removal rate. It is important in the body can result to a serious and lasting brain damage, convulsion and death (Tsenten *et al.*, 2014). This implies that, the high content of lead found in Kuje suburbia is due to the poultry farms activities, the contamination can directly or indirectly have adverse effect on the farmers through cultivation and also on plants in the study area, and when consumed may result into severe and permanent brain damage.

4.2.3 Air quality

In relations to poultry contaminants, poultry productions release pollutants such as Ammonia (NH3)), Sulphur dioxide and methane. Other pollutants such as volatile organic compounds (VOCs), Particulate Matter (PM) including PM2.5, and Hydrogen Sulphide could have harmful health impact as well as respirational circumstances which include bronchitis, asthma in children, heart disease, and lung cancer. But in this research, only three (3) pollutants; Particulate matter (PM2.5), Sulphur Dioxide (SO2) and (CO2) were read and perceived while in the other hand Nitrogen Dioxide and Combustion gases (methane and methane were not read in the study area.

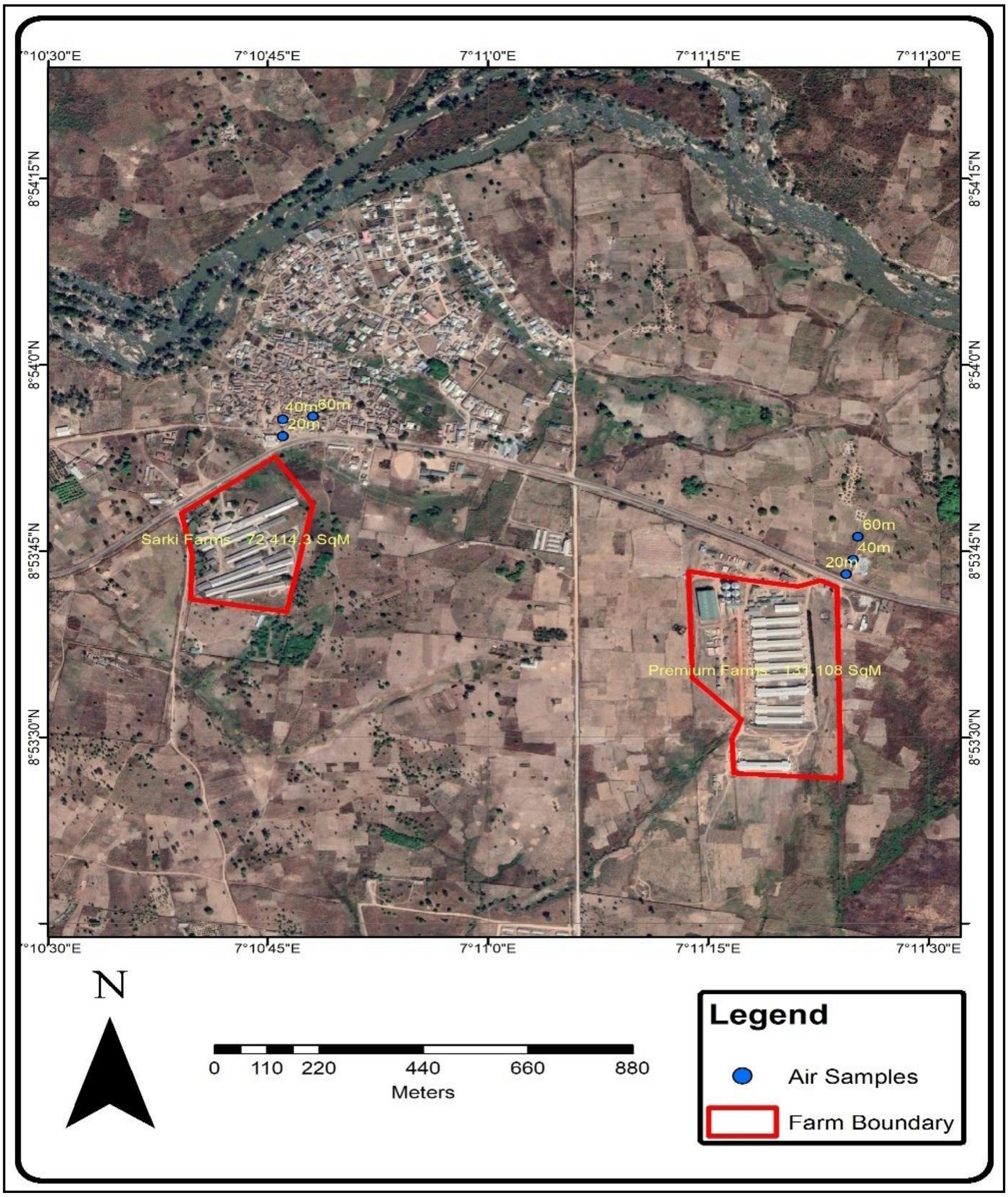

Figure 4.5: Satellite Imagery of Air Quality points
Source: Author's Field Survey, (2020)

4.2.3.1 Particulate matter ($PM_{2.5}$)

The level sample of Particulate matter ($PM_{2.5}$) was measured, during production at about 8.00am and after production around 5:00pm. During production, the air quality was measured at four basic point from the fence at interval of 20meters, 40meters and 60meters respectively. At both Sarki and Premium fence (245m and 243m), 20meters away from the fence was (254m and 252m), 40meters away was recorded (236m and 229m) and 60meters away was recorded 280m and 275m. After production at the fence of both Sarki and Premium farms were recorded (247m and 244m) 20meters away were recorded (232m and 235m), 40meters away were recorded (250m and 249m) and at 60meters away were also recorded (273m and 281).

The results show that, at the poultry farms fence and 40meters away from the poultry farms the readings were below the standards of 250ug/m^3 by ministry of environment. Also at 20meters and 60meters away, the readings were high and above the standards. This implies that the particulate matter pollutants from the poultry farms have adverse effects on residents of which could lead to health impact as well as respirational conditions such as; bronchitis, asthma in children, heart disease, and lung cancer in Kuje suburbia.

4.2.3.2 Sulphur dioxide (SO_2)

The level sample of Sulphur Dioxide (SO_2) was measured, during production at about 8.00am and after production around 5:00pm. During production, the air quality was measured at four basic point from the fence at interval of 20meters, 40meters and 60meters respectively. At both Sarki and Premium fence (0.05ppm and 0.03ppm), 20meters away from the fence was (0.07ppm and 0.05ppm), 40meters away was recorded (0.07pm and 0.06ppm) and 60meters away was recorded 0.3ppm and 0.5ppm. After production at the fence of both Sarki and Premium farms were recorded (0.04ppm and 0.07ppm) 20meters away were recorded (0.04ppm and 0.05ppm), 40meters away were recorded (0.1m and 0.2ppm) and at 60meters away were also recorded (0.2ppm and 0.3ppm).

The concentration of Sulphur Dioxide(SO2) in all the points recorded during production at 60meters away from the fence exceeded the permissible limit of 0.1ppm. Also, after production the concentration of Sulphur Dioxide (SO2) in all the points recorded at 40meters and 60meters away exceeded the permissible limit of 0.1ppm and therefore pose environmental concern.

4.2.3.3 Carbon monoxide (CO_2)

The level sample of Carbon monoxide (CO_2) was also measured, during production at about 8.00am and after production around 5:00pm. The Air quality were measured at four (4) basic point from the fence at interval of 20meters, 40meters and 60meters respectively. the results of the Carbon Monoxide (CO2) air quality analysis at both Sarki and Premium farms the measurement was taken at an interval of 20meters, 40meters and 60meters. The result shows that before production CO_2 air quality measurement was 4ppm and 2ppm within 20meters for both farms, 6ppm and 7ppm within 40meters, 9ppm and 10ppm within 60meters for both Sarki and Premium farms.

During production the CO_2 air quality measurement shows 6ppm and 5ppm within 20meters, 8ppm and 8ppm within 40meters while 7ppm and 8ppm within 60meters distance to the fence of both farms, equally after production are 3ppm and 2ppm at 20meters, 5ppm and 5ppm at 40meters while 6ppm and 7ppm at 60meters. After production, the CO2 air quality measurement show 3ppm and 2ppm within 20meters, 5ppm and 5ppm within 40meters and 60meters away recorded 6ppm and 7ppm. The readings at far distances 40meters and 60meters revealed that the pollutant is higher while at close distances the pollutant is perceived lower, it also indicated that CO_2 was recorded higher during production and above the standard of 10ppm by the Federal Ministry of Environment (2008) at 40meters and 60meters away from the both poultry fence. However, the CO2 air quality analysis reveals that the high content of CO2 recorded is as a result of the poultry production activities in the study area through movements of vehicles and machines processing chicken feeds. This implies that the poultry production both Sarki and Premium farms activities have adverse effects on the study area which may result into some health effects such respiratory

4.3 Residents Perception of the Poultry Farms

Appendix F presents the grand mean score of respondents ‘perceived knowledge was 4.60. This indicated high knowledge of poultry farm on environmental issues associated with poultry farming in the study area. Similarly, residents in the study area have good information of the adverse environmental impacts associated with poultry production in Kuje Suburbia. This result indicated that, mean score 4.70 shows neighbours vacating from the area due to odour, mean score 4.69 shows odour prevents them from opening windows, mean score 4.68 shows odour from the farms prevents them from relaxing outside and mean score 4.59 shows that the poultry farms are source of environmental pollution in the area. This result indicated that, the resident’s perception of environmental impact of poultry farms in the study area was high.

4.4 Nature and Level of Complaints by Residents on Poultry Farm Activities in Kuje

4.4.1 Residents complaint of the poultry farms in Kuje suburbia

The complaints against poultry farms were of different types as shown in Table 4.6. the result shows that 61.1% indicated that bad odour from poultry farms was the major complaint against poultry farms. Only 28.3% indicated that rats/flies constituted the type of complaint while and 5.8% of the residents complained against noise from poultry houses. The findings imply that bad odour from poultry farms constituted the major types of complaint against poultry farms. This agrees with (Bough, 1992; Alabi *et al.,* 2010) observations that wet contaminated litter in poultry houses give rise to unpleasant odour which can be a source of annoyance for the workers and nearby communities.

The frequency of complaint of hazards from poultry farms is a measure of the awareness of such problems by residents with a view to finding solution to the problem as shown in Table 4.6. Table 4.6 shows that 8.3% of the respondents complained 1-2 times about environmental hazards, 35.8% complained 3–4 times, 40.3% complained 5-7 times while 15.7% made complaints of hazards exposure from poultry farms in their neighbourhood to concerned authorities. The fact that as much as 100% of the respondents made complaint is in confirmation in the findings of Alabi *et al.* (2014) that majority of the people living close to poultry farms are aware of the environmental hazards associated with living in poultry farm vicinities.

The table shows that 81.1% responded that there has been litigation between the community and the poultry farms. 28% respondended the ligitation problem of environmental pollution caused by the poultry farms , 27% on bad odour, 18.6% respondents on environmental hazards and pollution, 17.5% on problem of rats and flies from the farms makes the environment unpleasant for them and 8.3% respondents indicated nothing. This implies that there has been litigation between the residents and the poultry farms in the study area. Also, From the survey, it was revealed that 46.6% respondents said the types of birds kept by the poultry farms are layers while 22% respondents said broilers, 8% said nuellers while 11.9% responded fisheries and 11%

indicated none. This implies that the majority of birds kept by the poultry farms are layers and broilers. Table 4.7.1 further reveals that, the associated diseases common in the study are: typhoid, fever, malaria and cholera. The findings support the report of World Bank (2007) that rats, cockroaches, flies and parasites could spread illnesses, including; malaria, fever, typhoid, cholera and dysentery. Though fewer frequently reported than rats, flies, mosquitoes and related pests are likewise local irritation associated with poultry farming. This shows that, because of pollution and other adverse effects from the poultry farms leads to these diseases.

From the survey, 21% respondents said they are comfortable with the existence of peri-urban and urban poultry farms while 55% respondents indicated that they are not comfortable with the existence of peri-urban and urban poultry farms in Kuje suburbia. The table also shows that, 25% respondents in event of the COVID-19 pandemic are not comfortable with the existence of peri-urban and urban poultry farms because of air pollution to the environment from the farms while 26.9% respondents said air pollution from the farms causes health effect while 24.7% said associated poultry diseases could be transmitted through air pollution and 23% indicated none. This finding shows the level of complaints on environmental pollution was high amongst residents in the study area.

Table 4.4: Level of Complaint by Residents

Responses	Frequency	Percentage
Bad Odour	220	61.1

Noise	21	5.8
Rats/flies	102	28.3
None	17	4.7
Total	360	100
Litigation Between Community and the Poultry Farms		
Yes	330	81.1
NO	30	18.9
Total	360	100
Frequency of Complaint of Environmental Hazards by Residents		
1-2	30	8.3
3-4	129	35.8
5-6	145	40.3
6-7	56	15.7
Total	360	100
Litigations		
Environmental pollution cause by the poultry farms	101	28
Bad odour	99	27
Environmental hazard and pollution	67	19.7
Rats and flies within the environment	63	17
None	30	8.3
Total	360	100
Associated Diseases Common in your Area		
Typhoid	87	24
Malaria	93	25
Fever	99	27.5
Cholera	81	22.5
Total	360	100
Comfortable with the Existence of Peri-Urban and Urban Poultry Farms?		
Yes	77	21
No	199	55
None	84	23
Total	360	100
Reason		
Environmental hazard	91	25
Air pollution from the poultry farms can cause health effects	97	26.9
Associated poultry diseases could be transmitted through air pollution	89	24.7
None	83	23
Total	360	100

4.5 Summary of Findings

The research results revealed that Six (6) poultry farms are in operation and functioning in large quantity (BKK farm, Ashmaid farm, Kiram farm, Sarki farm, Premium farm and Eugo farm). And the birds raise by the poultry farms are mostly layers and broilers some of these poultry farms are a bit distance from residents with about 1km to 2km. Even though from the survey carryout, Sarki farms and Premium farms are few farms that are closely located to residence, which are basically the source of environmental pollution or hazard in Kuje Suburbia.

Plate IV: Farm B Disposal Method
Source: Author's Field Survey, (2020)

The stream water, borehole water and well water sampled were contaminated with Total Alkalinity (TA), of (82mg/l, 169mg/l and 45mg/1) respectively, which the excessive of it can produce toxic effect on human and animals. Manganese level of the stream water, borehole water and well water sampled are high and high Manganese is an indication to produce toxicity such as cancer or reproductive damage, as in Table 4.3.

Also, there was detection of high Phosphate, Nitrate and Biochemical Oxygen Demand (BOD) in the three water sampled all above the WHO/NESREA standard guidelines. This involves all the dissociated electrolytes, that makeup salinity concentration including some complexes such as liquefied carbon-based matter in polluted area water.

The level of the contamination of the poultry farms activities on the surrounded residents source of drinking surface water, well water and borehole water has its results for Surface water, Borehole water and Well water to be as follows; surface water, borehole water and well water was contaminated as the result indicated high value of Total Dissolved Solids (TDS), Manganese, Biochemical Oxygen Demand (BOD), Phosphorus and Nitrate count all above the WHO/NESREA's standard limits. Excess of Total Dissolved Solids (TDS) could produce deadly effect on human and animals. High value of Nitrate content was discovered in the three sampled water. A high concentration of Nitrate concentrations is observed dangerous and could result to methemoglobinemia in children below six (6) months as well as health impacts, such as diarrhoea and respiratory diseases, in table 4.3. The test results revealed the findings of (FAO, 2001), that poultry wastes harbour pathogens such as virus and bacteria as well as other pathogens which can contaminate drinking water with substantial level of nitrates, potentially fatal to infants.

The soil analysis results reveal that, the Calcium concentration of soil sampled at the four locations were above the WHO/NESREA standard guidelines in table 4.4. However, the manganese level was high at soil sampled 20meters, 40meters, 60meters and soil D away from the poultry fence in figure 6. The organic matter was present at 20meters and 60meters locations. But minimal at 40meters and Soil D location, but are within the standard guidelines. This shows the level of contamination in figure 6. Furthermore, the Lead present in the soil sampled at the four locations were above the permissible limits. When there is high concentration of Lead (Pb) in the body may lead to a serious and lasting brain destruction, convulsion and death.

The air quality analysis of Particulate Matter (PM2.5) shows that, there was high presence of PM2.5 emissions, which were measured, as (280µg/m3 and 273µg/m3) before and during production at sarki farm and at 60meters distance, (275µg/m3 and 281µg/m3) at 60meters distance from premium farm as seen in appendix B which are above the Federal Ministry of Environment (2008) limits of 250µg/m3. Cao *et.al.*, (2017); Wilker *et.al.*, (2015), stated that, exposure to PM2.5 leads to poor reproductive and decreases brain function.

The analysis of Sulphur dioxide (SO_2) air quality measured shows that, (0.3ppm and 0.5ppm) at 60meters from Sarki farms and (0.2ppm and 0.3ppm) at 60meters away from Premium farm were above the Federal Ministry of Environment (2008) limits of 0.1ppm. The Federal Ministry of Environment stated that, Sulphur dioxide can cause respiratory problems such as bronchitis and can also infuriate nose, throat and lungs and this may lead to coughing, asthma, sneezing and phlegm. The analysis of CO_2 air quality shows that, there was high presence of CO_2 emissions, which were measured as (10ppm) during production at 40meters distance from premium farm but are within permissible limit standard of Federal Ministry of Environment.

The interviewed with the respondents revealed grand mean score 4.60 of the respondents' perception of the impacts of poultry farms activities, which shows an indication that the poultry farms pose environmental concerns on residents in the in the study area, as in table 4.5. Also, it was revealed that, majority 61.1% of the respondents complained about the locations of the poultry farms pollutes their environment with bad odour and 28.3% complaint that the poultry farms attracts rats/flies into the environment. This indicates that the locations of the poultry farms pose environmental concern in Kuje suburbia.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study has shown that the poultry farms activities have adverse impacts on their environment in Kuje sub-urbia. Findings reveals high concentration of heavy metals in water and soil by activities of the poultry farm in Chibiri community. Thus, the poultry farms are source of environmental pollution in the area and constitute public health challenge. Water and soil quality (drinking, domestic purposes, food manufacture or recreational purposes) has a significant effect on community well-being. Water of poor quality can lead to disease outbursts, and it can contribute to contextual rates of disease exhibiting themselves on diverse time measures (Velavan and Meyer, 2020). Creativities to achieve the safety of water does not only promote public health, but also support socioeconomic growth and welfare as well.

The study, therefore, suggests the need for appropriate authority to determined and enforced distance between poultry farms and residences to alleviate the adverse impacts especially with the experience of the COVID 19 global pandemic. Government and the Poultry farms should embark on public enlightenment campaigns to the residents around the poultry farms, with a view to educate them about the negative impacts of their operations to the health and wellbeing. In addition, review of the existing planning approval system and development environmental management plan to reduce negative impacts of the poultry farms and ensure compliance to good management practice.

5.2 Recommendations

Based on the result obtained from the field survey analysis and result obtained from the water, soil and air quality test analysis in Kuje suburbia the following recommendations.

1. Form of poultry production farms – the study shows that the forms of poultry production that exist in Kuje Suburbia are in medium and large scale. The findings also show that Farm A and Farm B are less than 0.5km to the residents therefore, reviewing of the existing planning approval system, in order to reallocate land to the poultry farmers far from the residents.
2. The findings revealed that some of this farms are not registered with regulatory bodies, therefore poultry farms handling more than 5,000 birds in a single location should be registered with regulatory agencies. Strict development control measures should be put in place, by restricting poultry farms development close to the residents so as to safe the public well-being and environmental performance and
3. Pollutants released associated with poultry farms - environmentally controlled poultry house is the housing system in which all the surroundings are maintained as near as to the bird's best necessities. For instance, poor ventilation leads to accumulation of ammonia, methane, hydrogen sulphide, carbon dioxide not only affects the performance of poultry but also has negative health effects on workers (Verma *et al.*, 2014). Hence, the concept of environmentally controlled poultry house could prove very good opportunity to address the concerns of one health.
4. Dust can cause respiratory problems, for instance reduce visibility and facilitate transmission of odours and diseases. In order to control dust, proper road facilities for the movement of vehicles in and around production facilities are required. Additionally, to reduce dust generation, dust collection systems particularly in feed grinding areas should be installed, wetting of vehicle parking lots that frequently travelled unpaved roads can be another option to minimize dust generation.

5. Level of complaints - the establishment of poultry farms close to human settlement has created environmental problems based on the level of complaint by residents in Kuje suburbia. Odour from poultry houses constituted the major complaint because of the low average distance between poultry farms and living houses. The study then recommends the necessity for appropriate distance between poultry farms and residences at least about 2.5 kilometre to be determined and enforced by regulatory authority. This will aid to mitigate the adverse impacts of poultry farm activities in Kuje suburbia.
6. This study should serve as a baseline study for Policy makers and Town Planners. As it is the work of Planners to reduce or mitigate public health and environmental risk hazard/ disaster.

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APPENDICES

Appendix A

DEPARTMENT OF URBAN AND REGIONAL PLANNING

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA NIGER STATE.

POSTGRADUATE QUESTIONNAIRE

QUESTIONNAIRE ON IMPACT OF URBAN POULTRY FARMS ACTIVITIES ON KUJE SUBURBIAN ENVIRONMENT, ABUJA, NIGERIA.

Dear Sir / Ma,

The aim of this questionnaire is to obtain information about the environmental impact of poultry farms in Kuje Suburbia (Chukukwu, Kiyi and Chibri) with a view to providing policy options for environmental sustainability in Kuje Area Council, Abuja. Any information provided shall be treated in stricked confidence and for academic purpose.

SECTION A: SOCIO-ECONOMIC CHARACTERISTICS

1. Name of location…………………………………………………………
2. Sex: (a) Male (b) Female
3. Age: (a)Under 20 (b) 21-30 (c) 31-40 (d) 41-50 (e) 51-60 (f) Above 60
4. Marital Status: (a) Single (b) married (c) widowed (d) divorced (e) others……………………
5. Level of education attained: (a) primary (b) secondary (c) graduate (d) non graduate (e) others
6. Occupation: (a) farming (b) trading (c)business (d)house wife (e)civil servant (f)others………………….
7. Years as residence (a)below 5(b) 5-10 (c) 11-15(d) 16 and above.
8. Number of poultry farm(s) around your area (a) < 5. (b)5-10 (c) 10 -15 (d) >15

SECTION B

RESIDENTS PERCEPTION OF THE POULTRY FARMS

Rank score on constructs used to measure the nature of environmental pollution effects of poultry farms on residents.

		Strongly Agree	Agree	Undecided	Strongly Disagree	Disagree
		5	4	3	2	1
1	Unpleasant odour from the poultry farm pollutes the air in our environment and causes discomfort to us.					
2	The waste disposal method of the farm breeds a lot of flies in the environment.					
3	Unpleasant odour coming from the farm house has caused some of our neighbours to vacate the area and relocate to another area.					
4	Odour from the poultry farm prevents us from being able to relax or eat outside our home					
5	Odour from the poultry farm prevents us from freely opening our windows					
6	Inappropriate wastes disposal from the farm has polluted the nearby stream in our neighbourhood					
7	Poultry wastes dumped around the farm invites more pests and rodents such as rats and cochcroaches to our environment					
8	Odour from the poultry farm causes low patronage of businesses in the area.					
9	Bad odour coming from the poultry house has resulted in low house rent in the area.					
10	Dead birds buried in the ground can decay and contaminate the ground water.					
11	Pesticides used in washing or disinfecting poultry house can cause pollution when they enter surface or ground water.					
12	Odour from the poultry farm hinders the sale/ reduces the value of properties in the neighbourhood					

13	My house is close to the poultry farm?					
14	The poultry farms are source of environmental pollution in your area?					
15	poultry farms in your area is associated Air pollution					
16	poultry farms in your area is associated Surface water pollution					
17	poultry farms in your area is associated Soil pollution					
18	major environmental concerns arising from poultry farms during production include Faecal, Feed and Carcass waste					
19	Living in **livestock**-dense areas has been associated with **health** effects					
20	Airborne exposures to **poultry farm** emissions have public **health effect**					

SECTION C
LEVEL OF COMPLAINTS BY RESIDENTS

1 Residents complain of the poultry farms in your area .

(a) Bad odour (b) Noise (c) Rats/ Flies' (d) None

2 Distribution of complaint of environmental hazard from poultry farms by residents per year

(a) 1- 2 (b) 3 - 4 (c) 5 – 6 (d) 6 -7 (e) None

3 Is there any litigation between your community and the poultry farms? (a) Yes (b)No

4 If yes, on what problem?

5 Types of the of birds kept by the poultry farms
…………………………………………
…………………………………………
…………………………………………
…………………………………………
…………………………………………
…………………………………………
…………………………………………
…………………………………………

6 Mention associated diseases in poultry common in your area
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…………………………………………
…………………………………………
…………………………………………

7 In event of the COVID-19 pandemic, are you comfortable with the existence of peri-urban and urban poultry farms? Yes / NO

8 If yes gives reason(s)…………………………………………
……………………………………………………………………………………
…………………………………………

9 If No, why……………………………………
……………………………………………………………………………………
…………………………………………

10 Your advice to the authority on urban poultry farms in your area
…………………………………………
…………………………………………
…………………………………………
…………………………………………

Appendix B

Table 3.3: Coordinates points of the poultry farm locations

s/no	Farm	Coordinate points
1	Premium (Farm A)	300962^{o}E 983672^{o}N
2	Sarki (Farm B)	299842^{o}E 983933^{o}N
3	BKK (Farm C)	296464^{o}E 985023^{o}N
4	Ashmaid integrated (Farm D)	296682^{o}E 984941^{o}N
5	Efugo (Farm E)	300068^{o}E 983672^{o}N
6	Kiram (Farm F)	296682^{o}E 984941^{o}N

Appendix C

Table 3.4: Physiochemical Characteristics of the Ground Water Quality Parameters in the study area.

s/no	Parameters	Testing method	Formula	Inventor /Users
1	pH	using pH meter and standardized with buffer 4, 7 and 10	pH = - log10 [H+] = log10 1/[H+] OR [H+] = 10-pH	ASTM Method, 1982
2	Electric Conductivity (EC) (µs)	Electrical conductivity of water depends on the ionic strength of such water which is related to the nature and concentration off dissolved substances in it and at what temperature.		APHA-AWWA-WEF, 1995
3	Total Hardness (TH) (mg/l)	Magnesium salt of 1,2 cyclohexanediaminetetraacetic acid. Add 250mg per 100 mL sample only if interfering ions are present and sharp end point is not obtained.	Total Hardness (EDTA), mg CaCO /L 3= A B 1000 / mL sample where: A = mL EDTA titrated for sample B = mg CaCO3 equivalent to 1.00 mL EDTA titrant	APHA-AWWA-WEF,1995
4	Total Alkalinity (TA) (mg/l)	Add 2 to 3 drops of bromcresol green indicator. Titrate until change in colour (blue to yellow, pH 4.9 to 4.3) is observed. Record total mL titrant used. (TITRIMETRIC TO PH=4.5)	Total alkalinity ,mgCaCO /L= B×N× 50000 / Ml samle	APHA-AWWA-WEF, 1995
5	Calcium (Ca) (mg/l)	Take 50 mL sample or an aliquot diluted to 50 mL such that the calcium content is not more than 10 mg. Samples which contain alkalinity greater than 300 mg/L should be neutralised with acid, boiled for 1 min and cooled before titration.	mg Ca/L= A B 400.8 / mL sample where: A = mL titrant for sample B = mL EDTA titrant mL of standard calcium solution taken for titration	APHA-AWWA-WEF, 1995
6	Manganese (Mg) (mg/1)	A suitable volume of sample, containing 0.05 to 2.0 mg Mn, was added in a 250 mL conical flask. Add 5 mL special reagent and one drop H2O2. Concentrate to 90 mL by boiling or dilute to 90 mL, add 1 g (NH4)2S2O8 and boil for 1 min then cool under the tap. Dilute to 100 m L with distilled water.	mgMn/L= µgMn/100mL / mL sample	APHA-AWWA-WEF, 1995
7	Sodium (mg/l)	10 mL diluted stock sodium solution with water to 100 mL; 1 mL = 0.1mg Na, prepare calibration curve in the range of 1 to 10mg/L		

8	Potassium (mg/)	10mL diluted stock potassium solution with water to 100mL; 1mL = 0.1mg K, prepare calibration curve in the range of 1 to 10mg/L Dilute 10mL intermediate solution with water to 100mL, 1mL = 10µg K, prepare calibration curve in the range of 0.1 to 1mg/L.	mgK/L mgK/L from the calibration curve × Dilution where: Dilution= mL sample + mL distilled water mL sample	APHA-AWWA-WEF, 1995
9	Phosphate (mg/l)	Take 50 mL sample into a 125 mL conical flask, add 1 drop of phenolphthalein indicator. Discharge any red colour by adding 5*N* H2SO4. Add 8 mL combined reagent and mix. Wait for 10 minutes, but no more than 30 minutes and measure absorbance of each sample at 880nm	o PO as mg P/L= mgP from the calibration curve×1000 mL sample	APHA-AWWA-WEF, 1995
10	Nitrate (mg/l)	To 800 mL water add 100 mL 85% phosphoric acid and 10g sulphanilamide. After dissolving add 1g N-(1-naphthyl)-ethylenediamine dihydrochloride. Mix to dissolve, then dilute to 1L with water. Solution is stable for one month when stored in dark bottle in refrigerator.	A= [(B C) (D E)] 7 F where: A = mg NO2 - - N/mL in stock solution B = mL total KMnO4 used C = normality of KMnO4 D = total mL oxalate added E = normality of oxalate F = mL stock nitrite taken for titration	APHA-AWWA-WEF, 1995
11	Biochemical Oxygen Demand (BOD) (mg/l)	1 ml of 0.025 N sodium thiosulphate=0.2mg of oxygen	D.O in mh in mg/l = (0.2x1000) ml of thiosulphat 200 B.O. D. in mg/l (D0-D1)- (C0-C1) mg X Decimal fraction of sample	Winkler Method, 1996
12	Chemical Oxygen Demand (COD)(mg/l)	15ml of concentrated Sulphuric acid with 0.3g of mercuric sulphate and a pinch of sliver sulphate along with 5ml of 0.025m potassium,dichromate was taken into a Nesslers tube.	COD,mgO /l 2=(A B) M 8000 ml sample where: A = FAS used for blank, mL B = FAS used for sample, mL M = Molarity of FAS	Winkler Method, 1996
13	Total Dissolved Solids (TDS) (mg/l)	Total Dissolved Solids (TDS) is solids in water, it comes from dissolved and suspended matter. Water with high solids contents have inferior palatability and probably induce unfavourable physiological reaction in some consumers		Winkler Method, 1996

Table 3.5: Physiochemical Characteristics of the Soil Quality Parameters in the study area.

s/no	Parameters	**Testing Methods**	**Formula**	**Inventors/Users**
1	Soil pH	The pH meter calibrated over the appropriate range using the manufacturer's instructions. The scoop was used to measure a 5 g soil sample into a paper cup and 5 mL distilled or deionized water added to the sample and stirred vigorously for 5 seconds and let stand for 10minutes.	pH = - log10 [H+] = log10 1/[H+] OR [H+] = 10-pH	Schofield, 1955
2	Conductivity	The Ni-HCL or Ni-EDL; a spectral gap width of 0.2 nm was carried out. Flame atomic absorption (FAA). Generally C2H2 – air flames are employed	C2H2 - N2O	Schlemmer G. and GIT Fachz, 2005.
3	Organic Carbon	500 ml of deionized water were put into 1 litere volumetric flask. 10 g are added to NaOH and 44.6 g of Na pyrophosphate and stirred until dissolved. Additional deionized water is added to make 1 L of solution; cap flask.	UV-V Add 41.43 ml of 37% HCl to the deionized water and stir.	Miller, 2011
4	Organic Matter			
5	Calcium			
6	Manganese	A standard magnesium solution is prepared by dissolving one gram of reagent-grade magnesium metal in dilute hydrochloric acid solution containing 400 milliliters of distilled water and 20 milliliters of concentrated hydrochloric acid.	No formula	Perkin-Elmer Model 303
7	Sodium	A standard sodium solution is prepared by dissolving 1.2710 grams of oven-dried reagent-grade sodium chloride in 100 milliliters of distilled water. Dilute to 1,000 milliliters with a 0.10 normal hydrochloric acid solution.		
8	Potassium	A standard potassium solution is prepared by dissolving exactly 0.9530 gram of oven-dried reagent-grade potassium chloride in 100 milliliters of distilled water. Dilute to 1,000 milliliters with a 0.10 normal hydrochloric acid solution.	No formula	Beckman Model B Flame Spectrophotometer.
9	Total Nitrogen	Weigh or scoop 5.0 ± 0.05 g of air-dried soil pulverized to pass 10 mesh sieves (< 2.0 mm) into extraction vessel. Add 25.0 m liter of 2.0 M KCl extraction solution	NO_3-N mg kg^{-1} in soil = (NO_3-N mg L^{-1} in filtrate - method blank) × 5.	Technicon Method No. 329-74W/A

		using repipette dispenser Place extraction vessel(s) on reciprocating mechanical shaker and shake for thirty (30) minutes.nitrogen (NO_3-N) from soil using 2.0 M KCl . Nitrate		
10	Lead	300g were digested dry ashing of the sample in a conventional oven; microwave digestion of the sample in a strong acid; acid digestion of the sample by heating in a pressure vessel;and dissolving the sample directly into acid. Some laboratories also extract the metals in 2-methylhexan-2-one [isobutyl methyl ketone (IBMK)].	No formula	Commission Regulation 333/2007

Appendix D

Air Quality Production Days of Sarki and Premium Farm

Sarki Farms Carbon dioxide (CO_2) Air Quality

Time of production	Fence	20meters away	40meters	60meters	FMENV Limits
	Source:299842° E 983933°N	Source:299844° E 983955°N	Source:299847° E 983996°N	Source:299910° E 984003°N	10PPM
Before	2ppm	4ppm	6ppm	9ppm	
During	4ppm	6ppm	8ppm	7ppm	
After	2ppm	3ppm	5ppm	6ppm	

Premium Farms Carbon dioxide (CO_2) Air Quality Analysis

Time of production	Fence	20meters away	40meters	60meters	FMENV Limits
	Source:299842° E 983955°N	Source:299842° E 983955°N	Source:299847° E 983996°N	Source:299910° E 984003°N	10PPM
Before	2ppm	4ppm	6ppm	9ppm	
During	4ppm	6ppm	10ppm	8ppm	
After	2ppm	3ppm	5ppm	6ppm	

Sarki farm particulate matter (PM2.5) Air Quality Analysis

Time of production	Fence	20meters away	40meters	60meters	FMENV Limits
	Source:299842° E 983955°N	Source:299842° E 983955°N	Source:299847° E 983996°N	Source:299910° E 984003°N	250µg/m3
Before	245	254	236	280	
During	247	232	250	273	

Premium farm particulate matter (PM2.5) Air Quality Analysis

Time of production	Fence	20meters away	40meters	60meters	FMENV Limits
	Source:299842° E 983955°N	Source:299842° E 983955°N	Source:299847° E 983996°N	Source:299910° E 984003°N	250µg/m3
Before	243	252	229	275	
During	244	235	249	281	

Sarki farm Sulphur Dioxide (SO2) Air Quality Analysis

Time of production	Fence	20meters away	40meters	60meters	FMENV Limits
	Source:299842° E 983955°N	Source:299842° E 983955°N	Source:299847° E 983996°N	Source:299910° E 984003°N	0.1ppm
Before	0.05ppm	0.07ppm	0.07ppm	0.3ppm	
After	0.03ppm	0.05ppm	0.06ppm	0.5ppm	

Premium farm Sulphur Dioxide (SO2) Air Quality Analysis

Time of production	Fence	20meters away	40meters	60meters	FMENV Limits
	Source:299842° E 983955°N	Source:299842° E 983955°N	Source:299847° E 983996°N	Source:299910° E 984003°N	0.1ppm
Before	0.04ppm	0.04ppm	0.1ppm	0.2ppm	
After	0.07ppm	0.07ppm	0.2ppm	0.3ppm	

Appendix E

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LABORATORY ANALYSIS RESULT SHEET.

SAMPLE ID	CONDTμS	TH mg/l	TA mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	P04 mg/l	N03 mg/l	PH	BOD mg/l	COD Mg/l	TDS Mg/l
STI	148	50	82	21.06	7.06	2.84	0.66	0.13	2.17	6.74	6.86	9.20	31.58
ST2	148	50	82	21.11	7.17	2.81	0.66	0.13	2.2	6.71	6.65	9.37	31.34
BHI	303	65	170	37.84	6.62	5.98	1.43	2.22	3.45	6.81	3.50	12.16	64.69
BH	305	65	168	37.8	6.65	5.93	1.45	2.26	3.42	6.83	3.50	12.12	64.73
WW1	437	70	44	42.05	6.81	3.53	0.77	1.95	5.62	6.76	8.20	16.72	93.65
WW2	339	70	46	42.1	6.78	3.55	0.79	1.93	5.58	6.75	8.34	16.58	93.61

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TECHNOLOGY.

LABORATORY ANALYSIS RESULT SHEET.

(SOIL SAMPLES)

SAMPLE	pH.	EC μS/cm	%OC	%OM	Ca mg/kg	Mg mg/kg	Na mg/kg	K mg/kg	P mg/kg	%TN
A	7.53	371	2.15	3.69	680	141.52	50.6	31.2	4.42	0.35
B	7.66	255	0.57	0.98	572	104.92	32.2	11.7	2.16	0.2
C	7.58	332	1.3	2.24	702	146.4	41.4	23.4	4.1	0.25
D	8.04	302	0.79	1.36	570	185.44	29.9	15.6	3.65	0.28

BABA, MB

Asst. Chief Technologist.

Appendix F

TABLE 4.5: Mean rank score on constructs used to measure the nature of environmental pollution effects of poultry farms on residents

s/n	Impact Statement	Strongly Agree (%)	Agree/(%)	Undecided (%)	Strongly Disagree	Disagree	Mean Score
		5	4	3	2	1	
1	Unpeasant odour from the poultry farm pollutes the air in our environment and causes discomfort to us.	195 (54.4)	163 (45.6)	2 (.6)	0	0	4.54
2	The waste disposal method of the farm breeds a lot of flies in the environment.	119 (33.1)	239 (66.4)	2 (.6)	0	0	4.66
3	Unpleasant odour coming from the farm house has caused some of our neighbours to vacate the area and relocate to another area.	254 (70.6)	103 (28.6)	3 (.8)	0	0	4.70
4	Odour from the poultry farm prevents us from being able to relax or eat outside our home	246 (68.3)	113 (31.4)	1 (.3)	0	0	4.68
5	Odour from the poultry farm prevents us from freely opening our windows	249 (69.2)	109 (30.3)	3 (.8)	0	0	4.69
6	Inappropriate wastes disposal from the farm has polluted the nearby stream in our neighbourhood	217 (60.3)	95 (26.4)	48 (13.3)	0	0	4.47
		199 (55.3)	161 (44.7)	0	0	0	4.55
7	Poultry wastes dumped around the farm invites more pests and rodents such as rats and cochcroaches to our environment	162 (45.0)	193 (53.6)	5 (1.4)	0	0	4.44
8		153 (42.5)	183 (50.2)	17 (4.7)	4 (1.1)	3 (.8)	4.33

	Odour from the poultry farm causes low patronage of businesses in the area.						
9	Bad odour coming from the poultry house has resulted in low house rent in the area.	77 (21.7	220 (61.1)	25 (6.9)	22 (6.1)	15 (4.2)	3.90
10	Lifeless chicken buried in the ground can decay and contaminate the ground water.	77 (21.4)	257 (71.4)	18 (5.0)	5 (1.4)	3 (.8)	4.11
11	Pesticides used in cleaning or sterilising poultry house could cause pollution when they enter surface or ground water.	169 (46.9)	128 (35.6)	34 (9.4)	11 (3.1)	18 (5.0)	4.16
12	Odour from the poultry farm hinders the sale/ reduces the value of properties in the neighbourhood	157 (43.6)	144 (40.0)	8 (2.2)	24 (6.7)	27 (7.5)	4.06
13	My house is close to the poultry farm?	150 (41.7)	146 (40.6)	17 (4.7)	25 (6.9)	22 (6.1)	4.05
14	The poultry farms are source of environmental pollution in your area?	223 (61.9)	128 (35.6)	9 (2.5)	0	0	4.59
15	Poultry farms in your area is associated Air pollution	141 (39.2)	206 (57.2)	13 (3.6)	0	0	4.36
16	Poultry farms in your area is associated Surface water pollution	172 (47.8)	142 (39.4)	16 (4.4)	14(3.9)	16 (4.4)	4.22
17	poultry farms in your area is associated Soil pollution	120 (33.3)	216 (60.0)	10 (2.8)	5 (1.4)	9 (2.5)	4.20
18							

19	major environmental issue rising from poultry farms during production include Faecal, and Carcass litters	117 (32.5)	198 (55.0)	18 (5.0)	10 (2.8)	17 (4.7)	4.08
20	Living in livestock-dense areas has been associated with health effects	239 (66.4)	87 (24.2)	23 (6.4)	3 (.8)	8 (2.2)	4.68
	Airborne exposures to poultry farm emissions have public health effect	225 (62.5)	103 (28.6)	11 (3.1)	13 (3.6)	8 (2.2)	4.46

Appendix G

Table 4.2: Identified Poultry Farms in the study area.

	Name	**Public /private**	**Proximity to built-up area**	**Production capacity**						**Volume**	**Solid waste generation**			**Mechanization**					**Disease outbreak**				**Registered**		
				scale	No of birds	Types of birds raised	Total birds house	Agro process	Agro production capacity	Land area sqm(hec)		types	Deep litter/batter cage system	Water pumping machine	Feed mixer	Power supply	Egg handling machine	Waste packing machine	Fowl typhoid	Newcastle disease	Avian leukosis	Infectious bursal disease	Area council	FMENV	EIA
A	Premium farm	Private	0.5km	Large scale	Over a million	Layers	10	Yes	50 bags of feeds daily	131108 (13.11)	10 tipper weekly	Composting, burning and burial	Battery cage	•	•	•	•	•	•		•		•	•	
B	Sarki farm	Private	0.04 km	Large scale	Above 300,000	Layers and broilers	11	No	Nil	72414.3 (7.24)		Flushing, composting and burning	Battery cage	•		•							•	•	
C	BKK farm	Private	2.5km	Medium scale	Above 150,000	Layers and broilers	8	No	Nil	68336.8 (6.83)		Composting and burial	Battery cage	•		•			•				•		
D	Ashmaid	Private	2.5km	large	Above 40	Layers,	6	Yes	100 bags of	58892.2 (5.89)		Composting, burnin	Battery cage	•		•	•					•	•	•	

	integrate farm			scale	0,000	broilers and chicken			feeds weekly			g and burial													
E	Efugo farm	Private	2km	large Scale	200,000	Layers and broilers	7	No	Nil	52941.7 (5.294)		Compositing	Battery cage	•		•							•	•	
F	Kiram farm	Private	2km	medium scale	50,000	Layers and broilers	5	No	Nil	47482.6 (4.75)		Burning , burial	Deep//battery cage	•		•							•	•	