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GLOBAL CLIMATE CHANGE GASEOUS EMISSIONS FROM PIGGERY FARMING IN IHIALA LOCAL GOVERNMENT AREA, ANAMBRA STATE, NIGERIA

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Abstract

The global climate change is partly occasioned by improper management of gaseous emissions arising from animal husbandry. The objective of the study is to investigate the emissions of climate change gases at piggery farms in Ihiala Local Government Area, Anambra State, Nigeria, so as to fill the knowledge gap that exists, due to the absence of any known study in the area by the researchers, on the subject matter. The multi-stage and random sampling techniques were used in selecting three big pig farms, one in Ihiala, Okija and Uil respectively that were studied. The methods of study were observation and experimentation. Results of the study indicated that solid wastes generated at the piggery farms were being indiscriminately disposed without any plan in place to recover carbon dioxide (CO₂) and methane (CH₄) as two major global climate change gases arising therefrom. In addition, the results revealed that the mean value of CO₂ was 1135.00 mg/m³, lower than 1300.00mg/m³ threshold limit by WHO/NESREA, while the mean value of CH₄ was 11.00mg/m³, far above 3.00mg/m³ permissible limit by the two regulatory institutions. The overall statistical analysis revealed that there was a significant difference (<0.01) in the concentrations of both CO₂ and CH₄ across the various locations of the piggery farms: Wilks' Lambda = 0.026, F (8.12)=7.76, p=0.001. The recommendations of the study include: (i) energy recovery of CO₂ and CH₄ for manufacturing minerals and use as cooking gas respectively; and (ii) drying of solid wastes arising from the piggery farms to reduce their decay which results in the production of the two climate change gases, among others.

Keywords: Carbon dioxide, global climate change, methane, piggery farms, solid wastes

1. INTRODUCTION

The global climate change is increasingly becoming a huge challenge to the world's environment and humanity in the 21st century, manifested in irregular rainfall, scorching heat of the sun and extreme weather events, among others. Animal husbandry and livestock sectors, which are partly contributors to the phenomenon, are critical for rural livelihood and economic development of nations (Lene, 2019). It opined that among the livestock species, pig constituted an important place as it was being reared by socio-

economically weaker sections of the society. Additionally, Lene (2019) argued that pig as compared to other livestock species has a great potential to contribute to faster economic return to the farmers, because of certain inherent traits like high fecundity, better-feed conversion efficiency, early maturity and short generation interval.

The increase in world's population and economic development, as well as changes in diet and better quality of life have made pork become a staple food worldwide (Alba, *et al.* 2019; Jadwiga, 2017). Pork represented 38% of the total animal meat consumed in the world in 2018 (Food and Agricultural Organization [FAO], 2020). The world's per-capita consumption of pork grew from 34.1 kg in 2016 to 44.6 kg in 2018 (FAO, 2020; Gonzáles, *et al.* 2020), which corresponded to 4.7% of the per-capita calories consumed within a conventional diet (FAO, 2020). As for the world's production of pork, it was 110,109 Mt in 2019, with a sustained average annual growth of 2.45% in the last 60 years, while the main producer in 2019 was China, and Mexico was the 13th with a production of 1.6 Mt (FAO, 2021). Maksym, *et al.* (2020) posited that China was the biggest producer and consumer of pork globally. Intensive pig production is a major livestock business enterprise in Nigeria, especially in the southern and north central zones of the country (Aminu & Akhigbe-ahonkhai, 2017; Nwachukwu & Udegbonam, 2020). It is important to state that pig farming is an important livelihood strategy that provides cash income, animal protein, and manure for many farmer households (Fang, 2022), however, with its attendant adverse impacts on the environment and human health when solid wastes arising therefrom are improperly managed.

Piggery farming is an essential component of the livestock industry, providing a significant source of food, employment, and income worldwide (Ottosen, *et al.* 2021). Wang, Ren and Bao (2018) opined that when in use as livestock, the pig was mostly farmed for its meat, pork. Other food products made from pigs include pork sausage (which included casings that are made from the intestines), bacon, gammon, ham and pork rinds (Maksym *et al.*, 2020). Alba *et al.* (2019) asserted that the head of a pig can be used to make a preserved jelly called head cheese, sometimes known as brawn. Its liver, chitterlings, blood (for black pudding), and other offal are also widely used for food. Nevertheless, in some religions, such as Judaism and Islam, pork is a taboo food (Holdaway, 2022).

According to FAO (2019), approximately 1.5 billion pigs were slaughtered each year for meat and animal protein production would grow at least 3 times by 2050, and meats (poultry, swine, and beef) would double while fish production would be multiplied by almost 10 times. Gonzalez *et al.* (2020) stated that the key challenge would be to produce sustainable food and, of course, sustainable feed to raise our animals, with limited availability of resources and with the need to reduce pressure on the environment. In the latter case, pig rearing is one of the traditional production activities and has lasted for thousands of years. It remains a critical contributor to the local economy (Fang, 2022) and pig meat is the meat type most produced and consumed globally (FAO, 2019), notwithstanding its significant contribution to several forms of deleterious environmental impacts.

Pig manure generates significant amounts of ammonia, which can be released into the atmosphere, leading to the formation of fine particulate matter that can cause respiratory problems (Dourmad, *et al.* 2016). Johnson, Smith, and Williams (2019), in extensive air quality assessments across various piggery farms, revealed that divergences in waste management approaches, farm layout designs, and ventilation systems substantially contributed to the distinct physicochemical characteristics of air quality. Additionally, piggery farms emit other gases such as methane, nitrous oxide, and carbon dioxide, which contribute to climate change (Rebollar, Martínez-Murcia & Chirino-Trejo, 2019).

A cursory observation of the piggery farms in the study area indicated that a lot of adverse environmental impacts emanate from its operations. The piggery farmers were less concerned for the proper management of both solid wastes and effluents generated from their farms. Some of the herders ignorantly fail to pay

attention to sustainable ways of managing the piggery wastes as they use open space discharge method for the pig dungs and effluents. This raises a lot of air quality issues, particularly the emission of global climate change gases. All the pig pens within the study area were spotted to be untidy, thereby introducing some sorts of malodorous smells within the environment in which the pens were located. This poor sanitary condition has potentials for releasing foul odors and climate change gases like carbon dioxide (CO₂), ammonia (CH₄) and nitrous oxide (N₂O). This research is therefore conducted to ascertain the extent at which piggery farming in the study area has contributed to the global climate change in its emission of CO₂ and CH₄.

2. METHODOLOGY

2.1 The Study Area

Ihiala Local Government Area is one of the local government areas in Anambra State, Nigeria. It lies approximately within latitudes 5° 47' 00"N, 5° 54' 00"N and longitudes 6° 47' 00"E, 6° 54' 00"E (Figure 1). It covers an area of 304km², bounded by Ogbaru Local Government Area in the west (Egboka & Okpoko, 1999). It is made up of autonomous communities. Geologically, the study area consists of two easily distinguishable geologic formations: the Ogwashi-Asaba Formation (Oligocene–Miocene) and the Benin Formation, with 6,000m deep sedimentary rocks and altitude of 142m (Obichukwu, 2014). Predominantly, the soils of the study area are derived from the underlying Sandstones and Shale units and are reddish brown clayey at the surface. They are well drained and weakly consolidated in most parts of the study area (Ndukwe, Francis, Kelechi, Chiamaka, Raphael and Amos, 2013). Ihiala Local Government Area is located within the rainforest belt. The rainforest belts are characterized by the growth of tall trees amidst thick undergrowth vegetation. The typical rainforest vegetation has almost disappeared giving rise to derived savannah, vegetation of shrubs and bushes because of many years of unsustainable human activities. The tree species found in the area include oil palm (*Elaeis guineensis*), pear (*Pyrus communis*), breadfruit (*Artocarpus altilis*), bamboo (*Bambusoideae*), orange (*Citrus sinensis*) and mango (*Mangifera indica*) (Momah, 2019).

The temperature of the area ranges generally between 18°C to 30°C from April to October (rainy season) and 21°C to 38°C (dry season) from November to February (Weather Spark, 2020). Generally, the study area is characterized by mean maximum temperature of 34°C and minimum temperature of 21°C (Orji, 2015). The study area has a tropical climate with the rainy season between April and October and a dry season from November to March [Nigeria Meteorological Agency (NIMET), 2012]. The annual rainfall ranges between 1,500mm and 2,500mm (ICWAT, 2020). There are two rainfall peaks, one in July and the other in September and annual precipitation is in excess of 2000mm (Obichukwu, 2014). According to NIMET (2012), it has an average yearly rainfall of 1500mm. During the dry season, the influence of the Sahara air mass affects 95% of the country (Iwena, 2010), including the study area. The average humidity ranges from 60% to 85% between March and October (wet seasons) while the minimum and maximum relative humidity is 35% and 85% during the dry season between November and February respectively (Obichukwu, 2014).

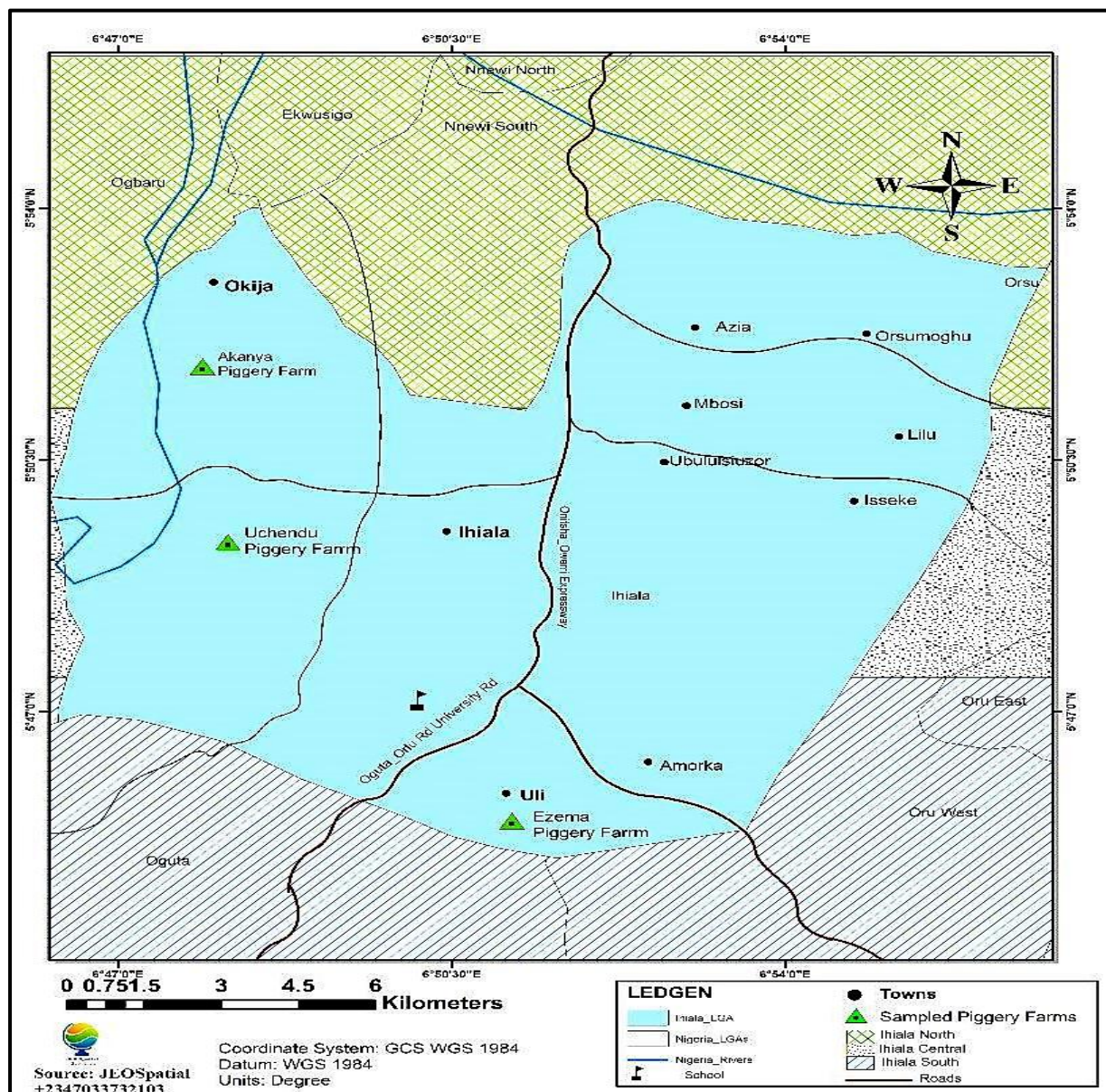


Figure 1: Base Map of Ihiala Local Government Area Indicating the 3 Sampled Piggery Farms

Source: JEO Spatial Map Services (2025)

2.2 Sampling Techniques

Two sampling techniques: multistage and simple random were used for the study. First, the study area was divided into three zones: north, central and south. This formed the first primary units. Then using a simple random technique, three towns, namely: Okija, Ihiala and Uli were chosen from north, central and south zones respectively. Additionally, using the same simple random technique, three piggery farms: Akanya. Uchendu and Ezema were chosen. Sample points: PT1, PT2 and PT3, were established respectively at the piggery farms, while sampling point PT4 was put in place 100m away from each of the points to serve as the background/control point for monitoring CO₂ and CH₄ only, excluding N₂O because of lack of optic

lens sensor for it in the hand-held gas chromatography. The Global Positioning System (GPS) of the sampling points were recorded using Garmin ® GPS.

2.3 Field Observation

This was used in observing the environments of the three studied piggery farms. The essence was to establish if there was proper management of the piggery solid wastes, mainly dung whose decay produces the climate change gases: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O).

2.4 Air Quality Monitoring and Analysis

The presence and concentrations of climate change gases in the piggery farms were actually determined by the use of hand-held gas chromatography, also known as gas meter or gas analyzer, technically equipped with the sensory ability to automatically analyze for a particular gas whose optic lens sensor has been installed. The researchers, through the assistance of a gas analyst, monitored the climate change gases. First, the analyst accompanied the researchers to the field for the purpose of ensuring proper operation of the device and as well reading the data displayed at the digital screen and interpreting it for sheet recording. Consequently, the researchers were able to operate the device adequately and obtained error free data from the field. With these sensors, the researchers monitored each of the gases: CO₂; and CH₄ in the 3 studied piggery farms respectively. It takes 5 minutes for the device to process and detect each gas presence and its concentration at that particular moment. The analysis was conducted for 3 sessions/periods of the day: morning (8am – 10am); afternoon (12pm – 2pm); and evening (4pm – 6pm).

When setting ambient air sampling units, procedures described by American Society for Testing and Materials (ASTM) (2001) and Harrop (2002) were followed. Monitoring sites were classified into two types: peaks and background. When selecting a monitoring site, parameters including possible chemicals or physical interference, locality, terrain, services and quarry activities were considered. A method approved by (ASTM) for specific parameters was used for each measurement. Aeroqual Monitor/Analyser was used to perform automatic analysis of ambient air through the use of physical properties and giving cyclic or continuous output signal. Air was continuously extracted from the atmosphere and a portion of the sample was sent to the analyser/sensor for the determination of the pollutant gas of interest. Sampling was carried out at each sampling point using an air monitor or sampler mounted on a platform, raised at a height of 1.5 to 2.0 meters from the ground. Sampling was carried out for a period of 30 minutes at each point.

3. RESULTS AND DISCUSSION

3.1 Field Observation

Results of the field observation indicated that solid wastes generated at the piggery farms were being indiscriminately disposed, where they undergo both aerobic and anaerobic decomposition producing CO₂ and CH₄. No plan was in place to recover the two major global climate change gases arising therefrom. The implication is that the gases are being added to the cloud of other such climate gases generated from various sources across the globe.

3.2 Air Quality Monitoring Analysis

The results of air quality monitoring of CO₂ and CH₄ conducted across the three distinct piggery farming locations: Akanya Piggery Farm in Okija; Ezema Piggery Farm in Uli; and Uchendu Piggery Farm in Ihiala are indicated in Table 3.1. The measurements were taken at different times of the day: morning (8:00 am -

10:00 am); afternoon (12:00pm- 2:00 pm); and evening (4:00 pm - 6:00 pm). Their respective minimum, maximum, and average values recorded in mg/m³ are clearly indicated in the table 1.

The average CO₂ concentrations were to some extent high, as it ranged from 1134.00 to 1499.00 mg/m³, reflecting the farms' little commitment to effectively manage carbon dioxide emissions far below permissible limits. Similarly, the average levels of methane (CH₄) exhibited very high values, ranging from 11.00 to 14.00mg/m³. This underscores clearly the farms' lack of prowess in controlling methane emissions, a significant minus for environmental sustainability. In the afternoon period, the average CO₂ concentrations were lower than those of the morning period, with the average values that ranged from 653.00 to 1243.00 mg/m³, still signifying lack of the capacity to effectively manage the gas. In a similar manner, CH₄ had average high values, ranging from 9.00mg/m³ to 11.00mg/m³. In the evening hours, the results continued to demonstrate effective gaseous emissions. The average CO₂ concentrations ranged from 877.00 mg/m³ to 1499.00mg/m³, while that of CH₄ was between 10.00 mg/m³-11.00 mg/m³.

In summary, the presented air quality monitoring results showcase consistent lack of adequate efforts across the three piggery farming locations to effectively manage gas emissions, maintaining air quality within permissible standards. The absence of any form of the farms' proactive measures have contributed to lack of controlling and minimizing potential environmental and health risks associated with CO₂ and particularly CH₄ emissions, which does not align with WHO/NESREA guidelines.

Table 1: Gaseous Emissions from the Sampled Piggery Farms

FARM LOCATIONS AND COORDINATES					
Time	Parameter/Range	Akanya Piggery Farm, Okija 5° 88' 70" N, 6° 85' 97" E	Ezema Piggery Farm, Uli 5° 76' 92" N, 6° 84' 75" E	Uchendu Piggery Farm Ihiala 5° 81' 16" N, 6° 81' 80" E	WHO/NESREA Standard Limit
Morning: 8:00 - 10:00 am	CO ₂ , mg/m ³ Min	1063.00	1180.00	1243.00	0.50
	Max.	1221.00	1212.00	1644.00	
	Average	1134.00	1187.00	1499.00	
	CH ₄ , mg/m ³ Min	13.00	11.00	11.00	0.027
	Max	15.00	12.00	12.00	
Afternoon: 12:00 - 2:00 pm	Average	14.00	11.00	12.00	
	CO ₂ , mg/m ³ Min	653.00	860.00	1243.00	0.50
	Max.	678.00	962.00	1586.00	
	Average	659.00	911.00	1438.00	
	CH ₄ , mg/m ³ Min	9.00	10.00	11.00	0.027
Evening: 4:00 - 6:00 pm	Max	13.00	12.00	14.00	
	Average	11.00	11.00	12.00	
	CO ₂ , mg/m ³ Min	683.00	1176.00	1243.00	0.50
	Max.	1070.00	1360.00	1644.00	
	Average	877.00	1268.00	1499.00	
	CH ₄ , mg/m ³ Min	7.00	9.00	11.00	0.027
	Max	14.00	11.00	12.00	
	Average	11.00	10.00	11.00	

Source: Researchers' field work, 2025

Table 2 indicates the outcomes of a comprehensive parameter analysis, thoughtfully juxtaposed against the backdrop of pertinent WHO/NESREA standards. These numerical representations offer insight into the environmental quality of a specific setting, raising key considerations about compliance, concentrations, and potential implications. The mean CO₂ concentration stands at 1135.00, a little bit below the WHO/NESREA standard of 1300.00. This yields a commendable percentage compliance of 87.31%. It is evident that the environment under scrutiny manages to adhere to the stipulated CO₂ threshold, affirming a degree of environmental equilibrium. In a stark contrast, the mean concentration of CH₄, at 11.00, significantly overshadows the standard limit of 3.00. With a compliance rate of 00.00%, it becomes evident that urgent attention is imperative to mitigate the excessive CH₄ levels. This data point resonates with the necessity for immediate intervention to rectify this discordance. Put together, CO₂ showed a measure of compliance, while CH₄ did not and as such emerges as a focal point for corrective action. However, even the CO₂ emissions that are within the stipulated standard are still a problem because it is an addition to other sources, whose coalescence create the global climate change phenomenon.

Table 2: Air Samples Compliance with WHO/NESREA

Parameter	Mean	WHO/NESREA Standard	Percentage Compliance	Decision (Remark)
CO ₂	1135.00	1300.00	87.31%	Compliant
CH ₄	11.00	3.00	00.00%	Non-Compliant

Source: Researchers' field work, 2025

3.3 Inferential Statistics of Air Quality Monitoring

The overall analysis revealed that there was a significant difference (<0.01) in the concentrations of the two gases across the various locations of piggery farms: Wilks' Lambda=0.026, $F(8,12)=7.76$, $p=0.001$; no significant difference (>0.05) in the concentrations across the various time of the day: Wilks' Lambda=0.143, $F(8,12)=2.46$, $p=0.077$; and no significant difference (>0.05) in the concentrations across the interaction between the location and time of the day: Wilks' Lambda=0.268, $F(16,18.97)=0.64$, $p=0.816$ (Table 3).

Table 3: Variation of air quality across location of piggery farms and time of the day

Effect	Value of Wilks' Lambda	F	Hypothesis df	Error df	P-value (Sig.)
Location of farm	0.026	7.76	8.00	12.00	0.001
Time of the day	0.143	2.46	8.00	12.00	0.077
Location*Time	0.268	0.64	16.00	18.97	0.816

Source: Researchers' field work, 2023.

The significant variation in the concentrations of the two gases across the various locations of piggery farms could be attributed to the type of waste management system adopted in each sampled farm, characterized by open dumping of solid wastes, mainly dung and poor effluent pit management system.

4. CONCLUSION AND RECOMMENDATIONS

The study concludes that piggery farms in Ihiala are contributors to the global climate change, particularly with its very high emissions of NH_4 , a potent climate change gas. From the findings of the study, the following recommendations were made: (i) energy recovery of CO_2 and NH_4 for manufacturing minerals and use as cooking gas respectively; (ii) drying of solid wastes arising from the piggery farms to reduce their decay which results in the production of the two climate change gases; (iii) public education and awareness targeted on piggery farmers and all who are likely involved in this livestock farming about the environmental and health implications of poor piggery farming practices; and enforcement of all relevant environmental laws and regulations on waste management at the farms by the regulatory agencies

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