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A REVIEW OF ENVIRONMENTAL IMPACTS OF PIGGERY FARMING

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Abstract

Piggery farming plays a significant role in the economy of different countries across the globe. Nonetheless, the rapid expansion of this industry raises concerns about its adverse environmental consequences. Therefore, the objective of this paper is to review the environmental impacts of piggery farming. The method used is the review of academic journals/articles, conference papers, internet materials, textbooks and publicly available materials on the environmental impacts of piggery farming. The results of the study indicated that previous authors whose works were reviewed had a convergent view that piggery farming has many adverse environmental impacts on land, water, air and human health as well as some beneficial impacts. The specific negative environmental impacts include (i) significant contribution to water pollution through the release of nutrients and pathogens from piggery solid waste; (ii) soil degradation by excessive application of piggery solid waste on land; (iii) emission of greenhouse gases—carbon dioxide (CO_2), methane (NH_4) and nitrous oxide (N_2O); (iv) risk of the transmission of the zoonotic diseases from the pigs to animals and humans; and (v) emission of ammonia (NH_3) from piggery farms which has severe adverse implications on biodiversity and human health. On the contrary, some of the beneficial impacts of piggery farming revealed by the review are (i) piggery solid waste is N-based manure useful in cropping activities to boost crop productivity; and (ii) improvement of livelihood and welfare of piggery farmers as well as a source of revenue to the government. The recommendations of this study include, among others: (i) the piggery sector should adopt sustainable practices to reduce the emission of greenhouse gases, collect methane as cooking gas and properly manage piggery solid waste; (ii) it is crucial that the appropriate authorities and the pig farm owners promote animal welfare and prevent the transmission of zoonotic diseases to ensure the safety of both animals and humans; and (iii) further researches are needed in this sector to explore its full beneficial impacts, develop innovative solutions and strategies to mitigate the adverse environmental impacts to ensure sustainable food security and economic growth.

Keywords: Environmental impacts, Piggery farming, Solid waste management

1. INTRODUCTION

The increases in world population and economic development, as well as changes in diet and better quality of life, have made pork become a staple food worldwide (Jadwiga, 2017; Alba, Barrera, Sarduy, Pérez, Hermida and Dewulf, 2019). Pork represented 38% of the total animal meat consumed

in the world in 2018 (Food and Agricultural Organization of the United Nations (FAO) (2020). World per-capita consumption of pork grew from 34.1 kg in 2016 to 44.6 kg in 2018 (FAO, 2020; Gonzáles, Marquès, Nadal and Domingo, 2020), which according to the FAO, corresponded to 4.7% of the per-capita calories consumed within a conventional diet. As for the world production of pork, it was 110,109 Mt in 2019, with a sustained average annual growth of 2.45% in the last 60 years, the main producer in 2019 was China and Mexico was the 13th with a production of 1.6 Mt (FAO, 2021). According to Maksym, Chemerys, Dushka and Berezivskyi (2020), China was the biggest producer and consumer of pork in the world. 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 & Udegbunam, 2020). Piggery farming was an important livelihood strategy that provided cash income, animal protein, and manure for many farmer households (Fang, 2022).

Piggery farming was an essential component of the livestock industry, providing a significant source of food, employment and income worldwide (Ottosen, Mackenzie, Filipe, Misiura, and Kyriazakis, 2021). In the opinion of Lene (2019), animal husbandry and livestock sectors were critical for rural livelihood and economic development in India. According to Lene, India possessed one of the largest livestock wealth in the world and a quarter of the agricultural gross domestic product was contributed by the livestock sector. Lene argued that among the livestock species, the pig found an important place as it was being reared by a socio-economically weaker section of the society. Furthermore, Lene asserted that pigs as compared to other livestock species had a great potential to contribute to a faster economic return to the farmers, because of certain inherent traits like high fecundity, better-feed conversion efficiency, early maturity and short generation interval.

Wang, Ren and Bao (2018) stated that the pig was mostly farmed for its meat, pork. Other food products made from pigs were 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) opined that the head of a pig can be used to make a preserved jelly called head cheese, sometimes known as brawn. Additionally, Alba *et al*. stated that liver, chitterlings, blood (for black pudding), and other offal from pigs were also widely used for food. 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 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, Marques, Nadal and Domingo (2020) reported 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. Pig rearing has become a critical contributor to the local economy (Fang, 2022) and pig meat is the meat type most produced and consumed globally (FAO, 2019) and thus has contributed significantly to several forms of environmental impacts.

On the other hand, 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, Rouillé, Bonneau, Salaün and Guillouet, 2016). 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). Piggery farming also contributed to the development of antibiotic resistance, as pigs were often fed antibiotics to prevent disease and promote growth. According to Digiacomo and Leury (2019), antimicrobial resistance is a global health threat that could cause millions of deaths each year by 2050. Piggery farming could have a significant impact on human health due to the potential transmission of zoonotic diseases, for instance, the African Swine

Fever (ASF) outbreak in China in 2018 caused significant economic losses and threatened food security (Zhou, Li, Luo, Liu, and Miao, 2020).

Piggery farming could also impact animal welfare, as pigs were often confined to small spaces and may experience stress, injuries and diseases (Lei, Chen, Wang, and Chen, 2021). On several environmental occasions, runoff from pig farms could carry pathogens and antibiotics, which could lead to the development of antibiotic-resistant bacteria in water sources (FAO, 2019). More to that, eutrophication could lead to algal blooms, capable of depleting oxygen levels in the water, resulting in the death of aquatic life (Aschermann, Rose, and Sedlak, 2021). Moreover, the runoff from piggery farms could pollute nearby water bodies, leading to the contamination of drinking water sources (Mendez, Conforti, Anzuino, and Vitti, 2020). This review is an examination of the environmental impacts of piggery farming to lower the adverse impacts and enhance the beneficial impacts in this climate change-driven 21st-century

1.1 Statement of the Problem

Piggery farming is a significant contributor to the agricultural sector, and it plays a crucial role in meeting the protein demand of humans. However, the adverse environmental impacts of piggery farming have raised concerns globally. The problems associated with piggery farming include the following: pollution of water bodies; as well as generation of large quantities of solid waste that contains high levels of nutrients and organic matter. When the waste is not adequately managed, it can contaminate water bodies and cause eutrophication, leading to a decrease in water quality and aquatic life. Again, piggery farming generates greenhouse gases such as carbon dioxide, methane and nitrous oxide, which contribute significantly to global warming and climate change. The misapplication of pig waste to agricultural fields can result in soil degradation, leading to a decrease in soil fertility and crop yields. Worst still, piggery farming can pose health hazards to humans and animals due to the potential transmission of zoonotic diseases and its ability to generate malodorous smells, causing discomfort to workers and nearby residential areas.

1.2 Objective of the Study

The objective is to review works on the environmental impacts of piggery farming across the globe.

2. METHODOLOGY

Data used in this study was derived from published works, including academic articles, journals, conference papers, textbooks and internet materials. The researchers gathered 40 materials for the research but summarized the characteristics of 12, chosen across the globe, which centred on the environmental impacts of piggery farming. This enabled the researchers to make a synthesis of various authors' views on the activities of piggery farming and its environmental impacts.

3. CONCEPTUAL FRAMEWORK: ENVIRONMENTAL HEALTH

This study is based on the concept of environmental health, defined as those aspects of human health and disease that are determined by factors in the environment (World Health Organization [WHO], 2015). Environmental health is also defined as the interconnections between people and their environment by which human health and a balanced, non-polluted environment are sustained

(Encyclopedia, 2011). Environmental health addresses all the physical, chemical and biological factors external to a person and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that could potentially affect health (Novice, 1999). According to Novice, it is targeted towards preventing disease and creating health-supportive environments.

Environmental health addresses all human-health-related aspects of the natural environment and the built environment (WHO, 2015). According to Shona (2022), environmental health is a facet of public health and focuses on the relationship humans have with the environment Fresh air, clear water, shelter and a stable climate are just a few requirements for human health that link directly to the environment. Environmental public health urges us to understand this connection between the environment's health and our own. By looking at the health and safety of our environment, we can ensure that our own mental well-being and physical health remain intact. The following five topics are integral to supporting human life and building healthier environments: (i) water and sanitation; (ii) chemicals and radiation; (iii) air pollution; (iv) built environments; and (v) climate change. This study is tied to the aprons of the concept of environmental health because piggery farming impacts the environment linked to human health in various ways.

4. REVIEW OF RELATED LITERATURE

Hristov, Oh, Lee, Meinen, Montes, Ott, Frikins, Rotz, Dell, Adesogan, Yang, Tricarico, Kebreab, Waghorn, Dijkstra and Oostung (2013) conducted a study on the mitigation of greenhouse gas emissions in livestock production–a review of technical options for non-CO_2 emissions, using experimentation and observation. According to the authors, piggery farming contributed significantly to the emission of greenhouse gases (carbon dioxide, methane and nitrous oxide) and water pollution through the release of nutrients and pathogens from animal waste. Hristov *et al*. also opined that piggery farming produced a significant amount of manure that was not properly managed; it could contaminate nearby water sources, leading to eutrophication, algal blooms and death of fish. The authors recommended the use of best management practices, such as nutrient management plans and manure storage facilities to minimize the environmental impacts of piggery farming. Hristov *et al.* concluded that pig waste contained a high amount of nitrogen that could be converted to carbon dioxide, methane and nitrous oxide, which are greenhouse gases. Zhang, Chen, Chen, Li, and Li, (2019) studied environmental risks and countermeasures of livestock and poultry manure pollution in China, using experimental methods and observation. The authors reported that the discharge of untreated pig manure into rivers and lakes was a major source of water pollution in China.

Li, Cai, Wu, and Zhang (2018) investigated the water footprint of pig production in China using a questionnaire and laboratory analysis and reported that pig farming was a significant contributor to water depletion, consequently, the authors proposed the use of water-saving technologies such as drip irrigation and rainwater harvesting to reduce the water footprint of pig farming. Kebreab, Clark, Wagner-Riddle, France and Kyriazakis (2013) did a review on greenhouse gas emissions from pig production and found that piggery farming contributed to the emission of greenhouse gases, particularly methane and nitrous oxide. The study recommended the use of dietary interventions and manure management practices to reduce greenhouse gas emissions from piggery farming.

Heyden (2016) conducted continuous measurements of ammonia, nitrous oxide and methane from air scrubbers at pig housing facilities in Florida, using experimentation and observation. The result of the study showed that the biological air scrubber with an extra nitrification tank performed well in terms

of ammonia removal (86 ± 6%), while the two-stage air scrubber suffered from nitrifying bacteria inhibition. Hyden further reported that in the chemical air scrubber, the pH was not kept constant, lowering the ammonia removal efficiency. Hyden also claimed that lower ammonia removal efficiency was found during the day when the ventilation rate was the highest. Hyden argued that nitrous oxide was produced inside the biological and two-stage scrubber, resulting in an increased outlet concentration of more than 200%. Hyden concluded that methane could not be removed in the different air scrubbers because of its low water solubility. A study by Zhang, Yang, Liu, Tian, Chen, Cheng, and Zhang (2019) on soil degradation and agricultural sustainability under intensive pig production in China using observation, questionnaire and laboratory analysis indicated that piggery farming contributed to soil degradation through the excessive application of the piggery waste. Zhang *et al.* recommended the use of best management practices, such as proper nutrient management and soil conservation techniques to minimize the environmental impacts of piggery farming on soil quality.

Vivekananthan, Dupe, and Olalekan (2020) studied agro-environmental implications of N- and P-based manure application to perennial and annual cropping systems in Nigeria, using questionnaire, observation and experimentation. The results of the study indicated that the agronomic benefits of the N-based manure application (greater biomass yields) could also come with negative environmental impacts (increased Olsen P and NO_3-N leaching). The Olsen P was consistently greater and gradually increased over time in the N-based treatments with a bigger increase with the NSM treatment. This finding was a deviation from the first three-year observation where the surface Olsen P content of the NSM and NLM treatments did not significantly differ. Continuous manure application was shown to result in substantial sub-surface Olsen P losses in clayey and loamy textured soils that were prone to preferential flow. However, the differences in the surface Olsen P concentration were not reflected in the subsurface Olsen P leaching at this study site. Vivekananathan *et al.* claimed that the potential of N-based manure applications to produce greater barley and perennial grasses yielded than P-based applications. However, this came with an environmental cost as N-based cropping systems increased soil available phosphorus and subsurface NO_3-N leaching. Vivekananathan *et al.* recommended that future research should explore how P-based systems can be better managed for high Olsen P demanding crops with minimal environmental consequences.

Gerber, Steinfeld, Henderson, Mottet, Opio, Dijkman, and Tempio (2018) in a review on tackling climate change through livestock–a global assessment of emissions and mitigation opportunities opined that piggery farming contributed to greenhouse gas emissions, primarily through the release of methane and nitrous oxide from animal waste. The study recommended the use of best management practices, such as manure management and dietary interventions to reduce greenhouse gas emissions from piggery farming.

In China, Zhang, Yang, Chen, Gao, and Yang, (2018) reviewed greenhouse gas emissions from livestock and were of the view that piggery farming was responsible for 3.3% of China's total greenhouse gas emissions in 2015. Giraldi, Castillo-González, Medina-Salas, Velásquez, and Huerta-Silva (2021) researched environmental impacts associated with intensive production in pig farms in Mexico through life cycle assessment methodology. The research was focused on the following stages of the product system: (i) pig rearing and growth phases; (ii) production operations in the pig house; and (iii) the supply of feed. The life cycle inventory database was mainly made up of data collected during field visits to local farms. The functional unit was defined as one finished swine weighing 124 kg. Giraldi *et al*. further opined that the results for the selected impact categories of carbon, water, and energy footprints were 538.62kg Co_2aq, 21.34 m^3, and 1773.79 mj, respectively. In addition, Giraldi *et al*. claimed that the greatest impact was generated in the final stages of pig fattening, mainly due to the large quantity of feed supplied. According to the authors, the impacts caused by the operation of the

pig farm were less significant, their contribution in all cases was less than a third of the total quantified values. Giraldi *et al*. concluded that the energy conversion of pig slurry improved the environmental performance of the product system by reducing the carbon footprint.

In Europe, Susan, Sarah, Fay, Hadeel, Amelia, Becky, and Catriona (2018), reviewed the impact of ammonia emissions from agriculture on biodiversity: an evidence synthesis. Susan *et al.* argued that as levels of other air pollutants declined, ammonia emissions in the UK had been rising since 2013, with significant implications for biodiversity and human health. According to the authors, the agricultural sector was the biggest contributor to ammonia pollution, producing 82 per cent of all UK ammonia emissions in 2016. Susan *et al.* noted that ammonia itself and the nitrogen deposition resulting from ammonia emissions negatively affected biodiversity. Susan *et al.* stated that the major effect of ammonia pollution on biodiversity was the impact of nitrogen accumulation on plant species diversity and composition within affected habitats. Additionally, Susan *et al.* claimed that common, fast-growing species adapted to high nutrient availability, thrived in a nitrogen-rich environment and out-compete species which were more sensitive, smaller or rare. Susan *et al*. further asserted that wider education and awareness-raising might be needed to help build an understanding of the importance and costs of ammonia reduction amongst the public and in the retail sector so that the full cost of these measures were not placed solely on the agricultural sector and/or government subsidies.

Edo, Ihejirika, Okoli and Okoli (2020) performed a study on the socio-cultural and environmental impacts of pig farming on nearby residents in Imo State, Nigeria, using structured questionnaires, interviews and direct observation to generate data. The results of the study indicated that the environmental problems as perceived by the respondents were mostly associated with bad odour (47.00%), inappropriate dung disposal (38.00%) and animal noise (25.00%), not being addressed by the farmers. Most of the respondents (78.33%) stated that their friends had raised concerns, while another 61.67% had lost friends because of the environmental pollution problems. The authors concluded that the neighbours to the pig farms surveyed were mostly educated, married, and economically active persons who had similar socio-cultural characteristics to the farms. Edo *et al.* recommended the need for regulatory agencies to enforce the existing laws on the siting of livestock farms in residential areas in the state.

Table 1: Summary of characteristics of some studies that described the Environmental Impact of Piggery Farming

Authors	Topic of Research	Method	Result	Recommendation	Conclusion
Hristov et al. (2013)	Mitigation of greenhouse gas emissions in livestock production–a review of technical options for non-CO_2 emissions.	Literature review, observation and experimentation	Piggery farming contributed significantly to water pollution through the release of nutrients and pathogens from pig waste.	The use of best management practices such as nutrient management plans and manure storage facilities, to minimize the environmental impacts	Pig waste contains a high amount of nitrogen and carbon convertible to CO_2, NH_4 and N_2O
Zhang et al. (2019)	Environmental risks and countermeasures of livestock and	Questionnaire and experimentation	The discharge of untreated pig waste into rivers and lakes caused	Proper treatment of pig waste before discharging to	Piggery farming was a significant contributor to

	poultry manure pollution in China.		great water pollution in China.	any water body.	water pollution
Li et al. (2018).	Investigation of the water footprint of pig production in China.	Literature review.	Pig farming was a significant contributor to water depletion,	Piggery farming be given essential care to ameliorate the impacts of pollution on the environment.	Eutrophication led to algal blooms, depleting oxygen levels in the water and the death of aquatic life.
Kebreab et al. (2013)	Greenhouse gas emissions from pig production.	Experimentation and Observation	Piggery farming contributed to the emission of greenhouse gases: methane and nitrous oxide.	The use of dietary interventions and manure management practices to reduce greenhouse gas emissions	Piggery farms be assessed properly to reduce greenhouse emissions
Heyden (2016).	Continuous measurements of ammonia, nitrous oxide and methane from air scrubbers at pig housing facilities in Florida	Questionnaire, experimentation and observation	Methane, ammonia and nitrous oxide were produced in various degrees in the scrubbers	Continuous monitoring of methane, ammonia and nitrous various	The lower ammonia removal efficiency was established
Zhang et al. (2019).	Soil degradation and agricultural sustainability under intensive pig production in China.	Questionnaire, observation and experimentation	Piggery farming contributed to soil degradation through the excessive application of piggery waste	The use of best management practices, to minimize the environmental impacts on soil quality	Use of best management practices, to ensure sustainability
Vivekananthan et al. (2020)	Agro-environmental implications of N- and P-based manure application to perennial and annual cropping systems in Nigeria	Literature review	Agronomic benefits of the N-based manure application could also come with negative environmental impacts (Increased Olsen P and NO_3-N leaching)	Future research should explore how P-based systems can be better managed for high P-demanding crops with minimal environmental consequences	N-based manure applications produced greater yields than P-based applications
Zhang et al. (2018).	Greenhouse gas emissions from livestock	Literature review	Piggery farming was responsible for 3.3% of China's total greenhouse gas emissions in 2015	Appropriate measures should be adopted in combating air emissions from pig production	Using renewable energy biogas to reduce greenhouse gas emissions in pig farms

Gerber et al. (2018)	Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities.	Literature review	Global livestock accounted for 14.5% of all human-induced greenhouse gas emissions	The use of best management practices (e.g. dietary intervention) to reduce greenhouse gas emissions from piggery farming	Piggery production contributed almost 9% of total livestock's greenhouse gas emissions
Giraldi et al. (2021)	Environmental impacts associated with intensive production in pig farms in Mexico through life cycle assessment methodology.	Life Cycle Assessment methodology	Selected impact categories of carbon, water, and energy footprints were 538.62 kg CO_2aq, 21.34 m3, and 1773.79 MJ, respectively	Energy conversion of piggery slurry impacts cause	The energy conversion of pig slurry improves the environmental performance of the product system
Susan et al. (2018)	The impact of ammonia emissions from agriculture on biodiversity: an evidence synthesis.	Literature review	Levels of other air pollutants declined, and ammonia emissions in the UK have been rising since 2013, with significant implications for biodiversity and human health.	Wider education and awareness-raising are needed to help build an understanding of the importance and costs of ammonia reduction amongst the public and retail sector	Certain species and habitats are particularly susceptible to ammonia pollution
Edo et al. (2020).	Socio-cultural and environmental impacts of pig farming on nearby residents in Imo State, Nigeria	Questionnaire interview, and observation	Most residents thought that the piggery farm had polluted the environment through foul odour, contributed to household income of pig farmers	Regulatory agencies to enforce the existing laws on siting livestock farms in residential areas in Imo State	The environmental concerns were not serious enough to warrant protests/ closure of the farms, among others

Source: Adapted from Igwe, Nwezi, Echendu, Chukwunyere and Okonkwo, (2017)

5. RESULTS AND DISCUSSION

The studies reviewed have provided valuable insights into the environmental impact of piggery farming, including the contribution of pig waste (manure) to greenhouse gas emissions, water pollution, and soil degradation. The studies have also identified opportunities for reducing the environmental impacts of piggery farming through the implementation of sustainable practices such as

waste management, feed management, and manure utilization. All the authors whose works were reviewed; Hristov *et al*. (2013); Zhang *et al*. (2019); Li *et al*. (2018); Kebreab *et al*. (2013); Heyden (2016); Zhang *et al*. (2019); Vivekananthan *et al.* (2020); Zhang *et al*. (2018); Gerber *et al*. (2018); Giraldi *et al*. (2021); Susan *et al*. (2018); and Ihejirika *et al*. (2020) made use of standard methods for obtaining data and information for the studies which included experimentation, questionnaire, interview and review of related literature using internet materials, journals, books as well as bulletins.

The results of the review indicated that piggery farming has impacts on the environment and poses potential risks to humans, plants and animals. Table 1 summarises the characteristics of all the studies reviewed in this study. From the Table, Hristov *et al*. (2013) and Zhang *et al.* (2019) had a convergent view that piggery farming contributed significantly to water pollution through the release of nutrients and pathogens from pig waste. Kebreab *et al,* (2013) and Zhang *et al*, (2018) were of the convergent opinion that piggery farming contributed to the emission of greenhouse gases, particularly methane and nitrous oxide as it was responsible for 3.3% of China's total greenhouse gas emissions in 2015, while Giraldi *et al*, (2021) established that intensive production of pig farm led to the emission of carbon dioxide, a potent greenhouse gas. Similarly, Gerber *et al,* (2018) and Giraldi *et al*. (2021) concurred in the assertion that the global livestock sector was responsible for 14.5% of all human-induced greenhouse gas emissions.

Zhang *et al*, (2019) and Vivekananthan *et al*. (2020) had a unity of opinion that piggery farming contributed to soil degradation through the excessive application of pig waste. In the context of human, plant and animal welfare, Susan *et al,* (2018) and Lei *et al* (2021) were of the common view that ammonia itself and the nitrogen deposition arising from ammonia emissions negatively affected biodiversity. In terms of socio-economic impacts, Edo *et al.* (2020) expressed that there was a strong relationship between pig production, income and human population, claiming that pig farming contributed 40% to household income and that pig farming made the largest contribution to the household income of pig breeders. The authors also agreed that there was a significant positive relationship between the total human population and pig production.

Generally, the authors have contributed significantly to the research on the environmental impacts of piggery farming with the views that it had almost only adverse impacts on the components of the environment, human health and those of other life forms The studies have also identified ameliorative opportunities for reducing the adverse environmental impacts of through the implementation of sustainable practices such as waste management, feed management, and manure utilization.

6. RECOMMENDATIONS

Based on the results of this review, the following recommendations are made for building sustainable practices in piggery farming.

1. The piggery sector should adopt sustainable practices to collect greenhouse gases which have various useful purposes, exemplified by methane used as a cooking gas.

2. It is crucial that the appropriate authorities and the pig farm owners promote animal welfare and prevent the transmission of zoonotic diseases to ensure the safety of both animals and humans.

3. Future research is needed in this sector to develop innovative solutions and strategies to mitigate the environmental impact of piggery farming while ensuring food security and economic growth.

4. Since the negative environmental impacts of piggery farming are of significant concern, there is the need to take actions to minimize them such as the use of water-saving technologies, organic fertilizers, renewable energy sources and sustainable land management practices to be enforced by government through its appropriate regulatory agencies.

5. Except for the study by Edo *et al*. (2020), other reviewed studies concentrated on the negative environmental impacts of piggery farming, without due concern for the beneficial impacts in terms of (i) income in naira and kobo to pig farmers; (ii) revenue to the government in form of tax payable by the farmers; and (iii) employment opportunities offered by the piggery industry, among others. It is therefore recommended that more future research be focused on unveiling the full benefits of piggery farming.

7. CONCLUSION

In conclusion, piggery farming has significant negative environmental impacts that cannot be ignored. These impacts include water and air pollution, soil degradation and greenhouse gas emissions that cause global climate change. The works reviewed in this paper highlighted the urgent need for more sustainable practices in piggery farming to mitigate these impacts. This can be achieved through the use of proper management techniques for pig waste, the adoption of cleaner production methods and the implementation of effective policies and regulations. Failure to address these environmental impacts may result in long-term ecological and economic consequences that will mar the food security and economic benefits of piggery farming.

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